

RESIDENTIAL CONSTRUCTION GUIDE



*Pursuant to the
2010 California Codes*



Prepared by

City of San Bruno

Community Development Department

Building Division

567 El Camino Real

San Bruno, CA 94066

Phone (650) 616-7076

Fax (650) 873-6749

building@sanbruno.ca.gov

www.sanbruno.ca.gov

INTRODUCTION

This Residential Construction Guide has been prepared as an aid to the homeowner or contractor who is planning a residential construction project in San Bruno.

The guide refers to the following current editions:

- 2010 California Building Code (CBC)
- 2010 California Electrical Code (CEC)
- 2010 California Plumbing Code (CPC)
- 2010 California Mechanical Code (CMC)
- 2010 California Residential Code (CRC)
- 2010 California Administrative Code (Title 24) Energy Efficiency Standards
- City of San Bruno Municipal Code

Copies of these codes are available for reference at the City of San Bruno Community Development Department. When conflicts occur between the different codes regarding a certain item, the most restrictive or most specific code section applies.

General Design Criteria

1. San Bruno is in seismic zone E.
2. San Bruno is in climate zone 3.
3. Basic wind speed is 85mph.
4. Soil bearing pressure is based on 1,500 pounds per square foot, unless justified by a soils report.
5. Rainfall design is based on two inches per hour.

The Community Development Department (Building, and Planning Divisions) staff members are available to assist over the telephone **[(650) 616-7076 or 7074]** or at the public counter from Monday through Friday. General hours are as follows:

Community Development Department

8:00 to 5:00 (Hours are subject to change, please call or check web site to avoid delays)

Building Inspectors Office Hours:

8:00 to 9:00 and 4:00 to 5:00

Building inspection Hours:

9:00 a.m. to 12:00

1:00 p.m. to 4:00

Recommended Hours of Construction

7:00 a.m. to 7:00 p.m. Monday - Friday

8:00 a.m. to 6:00 p.m. Saturday, Sunday and Holidays

DISCLAIMER

This Residential Construction Guide is intended as a guideline only. The codes, interpretations and information may change, be updated, or corrected at any time without reprinting the guide. Refer to current editions of the California Building Codes for verification of requirements.

TABLE OF CONTENTS

PERMITS AND INSPECTIONS 1

HOW TO APPLY FOR A BUILDING PERMIT 1

 DO I NEED A PERMIT? 1

 WHO MAY APPLY FOR A PERMIT? 1

 HOW DO I APPLY FOR A PERMIT? 1

 HOW MUCH WILL IT COST? 1

PREPARATION OF RESIDENTIAL PLANS 2

 GENERAL REQUIREMENTS FOR NEW CONSTRUCTION AND ADDITIONS 2

 ENGINEERED DESIGNS 2

 INFORMATION REQUIRED ON DRAWINGS 2

 DEPARTMENTAL CLEARANCES 4

INSPECTIONS 5

CALIFORNIA BUILDING CODE 7

NONSTRUCTURAL DESIGN REQUIREMENTS 7

 EMERGENCY ESCAPE WINDOWS & ILLUSTRATION 7

 LIGHT, VENTILATION AND SANITATION 8

 CEILING HEIGHTS 8

 ROOM AREA 8

 WIDTH 8

 SMOKE ALARMS & CARBON MONOXIDE ALARMS 8

 HEATING 9

 ATTACHED GARAGES 9

 ATTACHED CARPORTS 9

 DETACHED GARAGES AND ACCESSORY BUILDINGS 9

 WINDOW AND DOOR REPLACEMENT 9

 WINDOW SILL HEIGHT 9

 GLAZING HAZAROUS LOCATIONS 10

 STAIRWAYS AND LANDINGS 11

 HANDRAILS 12

 GUARDS 13

FOOTINGS AND FOUNDATIONS 14

 SLABS ON GRADE 14

TYPICAL RESIDENTIAL FOUNDATIONS DETAILS 15

FLOOR JOISTS, GIRDERS AND POSTS 16

 UNDERFLOOR VENTILATION AND ACCESS 16

 PLYWOOD SUBFLOORING 16

WALL FRAMING 17

 SILL PLATES 17

 STUDS 17

 TOP PLATES 17

 CRIPPLE WALLS 17

 FIRE BLOCKING 18

 STRUCTURAL WOOD PANEL WALL SHEATHING 18

 CUTS, NOTCHES AND BORED HOLES FOR PIPING 20

| | |
|--|----|
| ROOF AND CEILING FRAMING..... | 24 |
| RAFTERS | 24 |
| RAFTERS TIES | 24 |
| PURLINS | 24 |
| ROOF SHEATHING | 24 |
| CEILING FRAMING | 24 |
| ATTIC VENTILATION AND ACCESS | 24 |
| ROOF COVERINGS | 24 |
| LOW SLOPE ROOFS | 24 |
| DRYWALL REQUIREMENTS..... | 29 |
| NAILING..... | 29 |
| CORNERS | 29 |
| DRYWALL IN SHOWER ENCLOSURES | 29 |
| DRYWALL IN FIRE RESISTIVE CONSTRUCTION | 29 |
| RECOMMENDED FASTENERS FOR DRYWALL | 31 |

CALIFORNIA MECHANICAL CODE..... 32

| | |
|--|----|
| GENERAL REQUIREMENTS FOR MECHANICAL EQUIPMENT..... | 32 |
| PROHIBITED LOCATIONS..... | 32 |
| ELECTRICAL REQUIREMENTS | 32 |
| ACCESS AND WORKING SPACE | 32 |
| SUPPORT OF EQUIPMENT | 32 |
| ELEVATION OF IGNITION SOURCE | 33 |
| CRASH BARRIERS..... | 33 |
| HEATING AND COOLING SYSTEMS..... | 34 |
| COMBUSTION AIR | 34 |
| VENTS AND CHIMNEYS..... | 34 |
| CONDENSATE | 35 |
| DUCT SYSTEMS..... | 35 |
| WALL FURNACES | 35 |
| WOOD-BURNING STOVES AND FIREPLACES..... | 36 |
| EXHAUST SYSTEMS..... | 37 |

CALIFORNIA PLUMBING CODE..... 38

| | |
|---|----|
| DRAINAGE AND VENTING SYSTEMS..... | 38 |
| MINIMUM SIZE OF TRAPS AND DRAINAGE PIPES..... | 38 |
| CHANGE-OF-DIRECTION FITTINGS..... | 38 |
| CLEANOUTS..... | 38 |
| SLOPE AND SUPPORT OF DRAINAGE PIPES | 38 |
| TRAPS AND VENTING - GENERAL..... | 39 |
| SPECIAL VENTING FOR ISLAND FIXTURES | 39 |
| VENT PIPE SLOPE AND CONNECTIONS | 41 |
| SIZE OF VENT PIPES | 41 |
| VENT TERMINATIONS..... | 41 |
| TESTING DWV SYSTEMS..... | 41 |
| SEWERS..... | 41 |

| | |
|-----------------------------------|----|
| WATER SUPPLY SYSTEMS | 42 |
| GENERAL REQUIREMENTS | 42 |
| BACKFLOW PREVENTION DEVICES | 42 |
| VALVES REQUIRED | 42 |
| PRESSURE REGULATORS | 42 |
| RELIEF VALVE | 42 |
| SIZE OF WATER PIPES | 42 |
| SUPPORT OF WATER PIPES | 42 |
| TESTING WATER SYSTEMS | 43 |
| FUEL GAS SYSTEMS | 44 |
| GENERAL REQUIREMENTS | 44 |
| CONNECTIONS | 44 |
| UNDERGROUND GAS PIPE | 44 |
| FLEXIBLE CONNECTORS | 44 |
| SIZE OF GAS PIPES | 44 |
| SUPPORT OF GAS PIPES | 45 |
| TESTING GAS SYSTEMS | 45 |
| NEW GAS SERVICE | 45 |

CALIFORNIA ELECTRICAL CODE..... 46

| | |
|---|----|
| GENERAL ELECTRICAL REQUIREMENTS | 46 |
| EXCEPTIONS TO THE RULES | 46 |
| COLOR OF CONDUCTORS | 46 |
| SIZE OF CONDUCTORS | 46 |
| ELECTRICAL CONNECTIONS | 48 |
| WET LOCATIONS | 48 |
| PROTECTION OF ELECTRICAL WIRING | 48 |
| ELECTRICAL DESIGN REQUIREMENTS | 49 |
| CIRCUITS | 49 |
| ARC-FAULT CIRCUIT-INTERRUPTER PROTECTION | 49 |
| RECEPTACLES | 49 |
| LIGHTING | 51 |
| SERVICES AND SUBPANELS | 52 |
| OVERHEAD SERVICE DROPS | 52 |
| DISCONNECTING MEANS | 52 |
| GROUNDING ELECTRODES | 52 |
| BONDING | 54 |
| ROUGH WIRING | 55 |
| GENERAL ROUGH WIRING REQUIREMENTS | 55 |
| GROUNDING | 55 |
| UNDERGROUND CONDUCTORS | 55 |
| TYPE NM CABLE | 56 |
| WIRING IN ELECTRICAL BOXES | 56 |
| SWIMMING POOLS AND SPAS | 57 |
| OUTDOOR POOLS, INDOOR POOLS, AND OUTDOOR SPAS | 57 |
| INDOOR SPAS | 57 |
| JETTED BATHTUBS | 57 |

CALIFORNIA ENERGY EFFICIENCY STANDARDS 58

| | |
|---|----|
| PURPOSE AND SCOPE | 58 |
| MANDATORY REQUIREMENTS | 58 |
| PILOT LIGHTS | 58 |
| JOINTS AND OPENINGS | 58 |
| MINIMUM INSULATION | 58 |
| FIREPLACES | 59 |
| SETBACK THERMOSTAT | 59 |
| WATER HEATER INSULATION | 59 |
| LIGHTING | 59 |
| COMPLIANCE METHODS | 60 |
| PACKAGE COMPLIANCE - PRESCRIPTIVE METHOD | 60 |
| APPROVED COMPUTER PROGRAMS - PERFORMANCE METHOD | 61 |
| ADDITIONS AND ALTERATIONS | 62 |
| ADDITIONS | 62 |
| ALTERATIONS | 62 |

TABLES AND ILLUSTRATIONS

| | |
|--|--------|
| WINDOW, EMERGENCY ESCAPE AND RESCUE | 7 |
| STAIR DETAIL | 11 |
| HANDRAIL | 12 |
| GUARDS | 13 |
| TYPICAL RESIDENTIAL FOUNDATION DETAILS | 15 |
| SIZE, HEIGHT AND SPACING OF WOOD STUDS | 17 |
| WALL BRACING SEISMIC DESIGN CATEGORIES D AND E | 19 |
| NOTCHING, CUTTING AND BORING GUIDE | 20 |
| NOTCHING AND BORING | 21 |
| WINDOW FLASHING | 22 |
| NAIL ON FIN WINDOW FLASHING | 23 |
| MAXIMUM ALLOWABLE SPANS | 25, 26 |
| TYPICAL CROSS SECTION VIEW | 25 |
| FASTENING SCHEDULE | 27, 28 |
| GYPSUM BOARD ATTACHMENT | 30 |
| RECOMMENDED FASTENERS FOR DRYWALL | 31 |
| VENT TERMINATION ABOVE ROOF | 36 |
| MINIMUM SIZE OF TRAPS AND DRAINAGE PIPES | 38 |
| SPECIAL VENTING FOR ISLAND FIXTURES | 39 |
| SEWERS | 40 |
| SIZE OF VENT PIPES | 41 |
| SUPPORT OF GAS PIPES | 45 |
| ALLOWABLE AMPACITIES OF INSULATED CONDUCTORS | 47 |
| COMMON RESIDENTIAL SERVICE REQUIREMENTS | 48 |
| GROUNDING SUBPANELS | 53 |

PERMITS AND INSPECTIONS

HOW TO APPLY FOR A BUILDING PERMIT

DO I NEED A PERMIT?

A building permit is required for new construction, demolition, remodeling or addition to a structure.

Other work requiring a permit includes, but is not limited to; windows and patio doors, carports, accessory structures exceeding 120 square feet, patio covers and most decks, bathroom and kitchen remodeling, termite and dry rot repairs, roofing and solar panels.

Permits are also required for plumbing and sewer work, mechanical work including furnaces and water heaters, and electrical work.

If you are in doubt as to whether a permit is required for your project, call the Community Development Department before starting.

WHO MAY APPLY FOR A PERMIT?

Property owners, authorized agents or licensed contractors may apply for a building permit. Contractors must provide Certificate **of Workers Compensation Insurance**. Property owners doing their own work will be required to sign the **Owner-Builder Verification** stating that they are actually doing their own work and are exempt from the requirement of having Workers Compensation Insurance, or they will be required to provide a certificate of insurance.

HOW DO I APPLY FOR A PERMIT?

The permit issuance process can be as simple as submitting the completed application form, having it reviewed by the Building Department Staff and having the permit issued after paying fees. For projects requiring plans, provide **three** complete sets of plans including energy, structural calculations, and truss specifications as necessary.

HOW MUCH WILL IT COST?

Building permit fees are based on the total estimated construction cost according to building valuation (per square foot) or contract price, including all materials and labor involved in the proposed work. A plan-checking fee is assessed at the time of plan submittal.

Plumbing, electrical, and mechanical permit fees are based on unit prices (such as how many receptacles, sinks, fans, etc).

For work done without permits, investigative fees are charged in addition to the normal fees for such work.

PREPARATION OF RESIDENTIAL PLANS

GENERAL REQUIREMENTS FOR NEW CONSTRUCTION AND ADDITIONS

Plans prepared by a design professional such as an architect or engineer must be stamped and signed on each applicable page. All pages must be numbered, with a title block including, job address, owner name, designer's name designer's address and phone number. No marked-over or altered plans will be accepted. If revisions are necessary or additional information is required the original drawings must be corrected and resubmitted.

Plans should be a minimum of 11" x 17" and for larger projects 24" x 36". All drawings must be to scale. Floor plans, elevations, foundation and framing plans must be drawn to a minimum scale of 1/4" = 1'. Graph paper is only acceptable if the grid lines are easily distinguishable from the drawing lines, including copies.

Completeness and clarity of the drawings is essential to avoid delays in issuance of your permit. Remember that the plan checker can only review your plans to the level of the information you supply. Your plans would be considered complete if you could give them to a total stranger and he or she could understand how the building will be constructed and what the finished project will look like.

ENGINEERED DESIGNS

When any portion of any structure deviates from substantial compliance with conventional framing requirements for wood-frame construction found in the code, the construction documents must be approved and stamped by a California licensed architect or engineer for that irregular or nonconforming portion of work. Two copies of structural calculations for such design with the designer's stamp, signature, and license number must be submitted. All design elements required by the calculations must appear on the plans. The builder or field inspector should not need to refer to the calculations to see how the structure is to be built.

INFORMATION REQUIRED ON DRAWINGS

For purposes of accuracy and clarity in plan review, construction and inspection processes, the following minimum plans standards are required.

Use this as a checklist when preparing your plans. Some items may not apply to your project but if you address all of those that do, unnecessary delays in the plan review process can be avoided. If you have questions about any of the items on this list we can discuss them with you.

Plot Plans must be provided for new buildings and for any work, which alters the footprint of an existing building. Plot plans must be drawn to a common engineers scale and must show:

- Property lines
- Lot dimensions
- Front, rear, and side setback distances to buildings
- Topographic features such as lot slope, trees and drainage flow
- All existing and proposed structures on the property including all covered patios, porches, roof overhangs, and driveway location.
- The proposed building's exterior dimensions
- All public and private easements
- Underground gas, electric and water lines
- Proposed and existing gas and electric meter locations
- North arrow showing the compass orientation

Foundation Plans are required. They should be drawn to 1/4"=1' scale, and include:

- All continuous footings with length of each segment
- Cross-section detail(s)
- Foundations for interior bearing walls
- Location of all pier footings (centers dimensioned in both directions)
- Size and depth of all pier footings
- Anchor bolt size and spacing, and types of post anchors
- Holdown locations and types - include bolt specification where applicable

For wood-framed floors the following are also required:

- Sizes of girders and joists
- Spacing of girders and joists
- Spans of girders and joists
- Additional joists or blocking under interior Braced Wall Panels
- Location and size of underfloor access
- Underfloor ventilation locations and calculations

For slab floors the following is also required:

- Footings or thickened slab under interior Braced Wall Panels with details for sill attachment.
- Vapor retarder below slab for habitable areas.

Floor Plans are required. They should be drawn to 1/4" = 1' scale, and include:

- A separate plan for each floor level
- Descriptions and dimensions of all rooms
- Locations and descriptions of all Braced Wall Panels
- Locations and sizes of doors and windows
- Description of window types (and doors if glazed)
- Locations and sizes of skylights (indicate if openable)
- Changes of ceiling height
- Location and size of attic access opening(s)
- Landings and stairs
- Plumbing fixtures and appliances
- Location and description of room heaters
- Location of heating and cooling appliances
- Method of providing combustion air for fuel-burning appliances in confined spaces
- Locations of electrical service panel, sub panels, receptacles, lights, switches, fans and smoke detectors (may need to be shown on a separate electrical plan if the floor plan is too crowded to maintain clarity)
- Header sizes for all openings in bearing walls
- For additions, adjacent existing rooms must be included
- For alterations to existing rooms, plans must show existing layout and proposed room changes.

Floor Framing Plans for the first story can be included in the foundation plan. If the building has more than one floor level, a separate floor-framing plan must be provided for each level unless no floor is above the other at any point (split level). See wood-framed floor section of foundation requirements.

Roof Framing Plans are required for all site-framed roofs. They are also required for site-framed portions of truss roofs, such as California framing, porch roofs, etc. Ceiling framing may be included on the roof-framing plan if adequate clarity can be maintained. Complex structures may need separate roof and ceiling framing plans. Plans must include:

- Sizes of rafters and joists
- Spacing of rafters and joists
- Spans of rafters and joists
- Locations and sizes of purlins
- Location of each purlin support, showing where a beam supports it or bearing wall
- Location, size, grade and span of each roof or ceiling beam
- Location and size of posts supporting roof or ceiling beams
- Attic ventilation locations and calculations

For truss roofs all of the following must be submitted:

- Truss layout
- Engineering for each truss and gable
- Gable stud bracing detail

Section Views are helpful for clarifying framing in complex buildings. Even in simple structures a typical section view can be very helpful. More complex buildings may require several section views.

Elevation views are required for each side of all new construction. They are usually drawn to 1/4" = 1' scale, but may be drawn to 1/8" = 1' scale if clarity is maintained. They should show:

- Approximate grade including actual slopes at the site
- Type of siding and roofing
- Windows, doors and skylights
- Architectural finish features
- Porches and decks
- Chimney extensions

Title 24 Energy Compliance Forms are required for projects creating heated or cooled space. These forms will show your method of compliance with California Energy Commission regulations for energy conservation. Basic forms are available from the Building Department, compliance forms for most projects are best prepared by an experienced professional. San Bruno is located in Climate Zone Three.

Simple projects may not require all of the items noted above. Each plan must provide the accuracy and clarity necessary for plan review, construction and field inspection. Plans that are inadequate for these purposes may be returned as incomplete, delaying your project.

DEPARTMENTAL CLEARANCES

Depending on the scope of the project, clearance may be required from the following departments: Clearance is required from the School District for residential projects, which add 500 or more square feet. Clearances are also required from the City Planning, Fire and Engineering Departments.

INSPECTIONS

It is the responsibility of the permit holder to notify the Building Department prior to covering work that requires inspection. Not all of the following inspections will apply to every job. If you are not sure which inspections pertain to your project, check with the Building Department before covering or continuing. Failure to call for a required inspection may result in your having to dismantle completed work to expose the area in question for inspection. Be sure that the permit, approved set of plans, and any related paper work, are available for the inspector at the time of inspection.

Setbacks – (clearly marked property lines) For some projects a survey will be required, and a certificate of compliance from a State licensed Surveyor.

Foundation - After grading, forms and steel placement is completed; trenches are cleaned out; and before pouring any concrete. Anchor bolts and embedded portions of hold-downs must be secured in place.

Underground Plumbing - All plumbing, including under slabs, must be inspected before any portion of it is covered. Drainage plumbing must be tested with a 10' head of water or 5 pounds of air on a gauge, which reads maximum 10 pounds full scale and has 1/10-pound markings. Water supply piping can be tested with working water pressure at site.

Slab - After grading, forming and steel placement is completed; trenches are cleaned out; after all piping, conduit etc., has been placed and inspected; and before pouring any concrete.

Underfloor - After all joists, girders, blocking, plumbing, heat ducts (with required insulation), electrical conduits and wiring have been installed and before any underfloor insulation has been installed.

Roof Sheeting – After roof framing and plywood nailing are complete and prior to covering. This inspection is usually done at the same time as exterior sheathing.

Exterior Sheathing - The nailing of sheathing, shear panel and brace panel areas, also all hold-downs, clips and straps are inspected.

Exterior Lath (stucco wire) - After all lathing, flashings and weep screed are in place.

Frame - After the roof is on and the exterior has been enclosed; framing, fire blocking and bracing is in place; and all pipes, chimneys, plumbing and heating vents and electrical wiring are complete.

Plumbing – All plumbing work must be inspected prior to covering. All new sewer lines, water lines and gas lines are required to under test for rough plumbing inspection.

Electrical - All electrical work must be inspected and approved before anything is covered. All fixtures must be inspected and approved at final inspection.

Mechanical - All flues, vents, heating ducts and chimneys must be inspected and approved after installation and before they are covered.

Insulation - After framing is approved, attic eave vents are baffled, insulation is installed, window and doorframes are caulked and sealed, and plate penetrations fire stopped and caulked.

Sheetrock - After all sheetrock has been installed, and prior to any taping.

Shower Pan – Job formed shower pan inspection is made after the pan is framed and hot-mopped or other approved shower pan lining material has been installed. A shower pan test must include completed drain connections with pan drain plugged and pan filled with water to top of dam, removal of the drain plug to verify that the weep system is working. The pan must slope ¼” per foot to drain, and drain completely with no standing water.

Gas Test - Gas piping including extensions to existing systems must be pressure tested with an approved gauge of 1/10 pound increments or less, the minimum initial test time is 10 minutes. A final test will be conducted after the sheetrock is installed. All gas appliances must be inspected and approved.

Roofing - All roofs require an in-progress, and a final inspection. San Bruno does not allow any overlays; a tear off of all old roofing materials is required. A class B fire rating minimum roofing material is required.

Smoke Alarms/Carbon Monoxide Alarms – All permits regardless of type or valuation will require a smoke alarm inspection in order to final the permit. Dwelling or sleeping units that have attached garages or fuel-burning appliances will also require carbon monoxide alarms.

Final – After all required inspections have been completed, the building is ready to occupy, any drainage work complete. If there are requirements or conditions associated with other departments, it is required to complete all conditions of approval prior to calling for final inspection from the building department.

The telephone number to request inspection is (650) 616-7076, or 7074 during normal business hours.

The approved Job Copy of the plans and the permit must be on-site and available to the inspector at the time of the inspection. If the approved plans are not available the job may be considered not ready for inspection, causing a delay to your project. If the work is not ready for inspection, a reinspection fee of \$125.00 can be charged.

If you have a question regarding a specific inspection, the inspectors are available in the office: 8:00 - 9:00 a.m. and 4:00 - 5:00 p.m., Monday through Friday.

CALIFORNIA BUILDING CODE

NONSTRUCTURAL DESIGN REQUIREMENTS

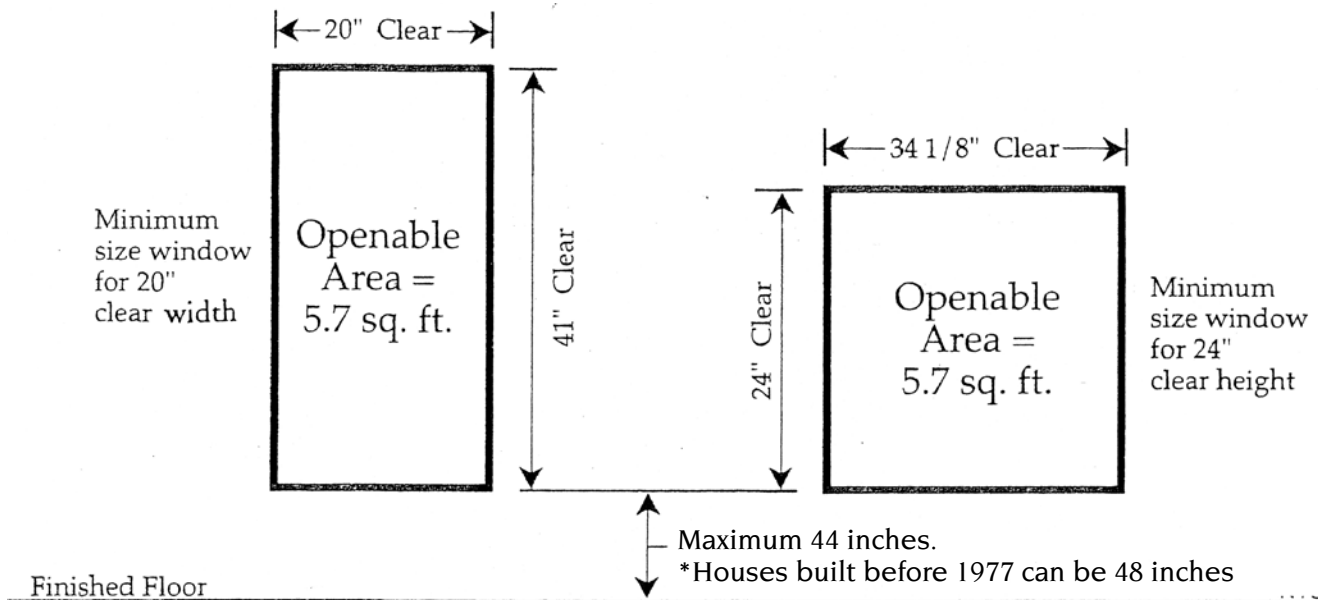
This section contains portions of the California Building Code that relate to basic minimum nonstructural design requirements for a residence.

EMERGENCY ESCAPE WINDOWS

Basements in dwelling units and every sleeping room below the fourth story shall have at least one operable window or door approved for emergency escape or rescue that shall open directly into a public street, public alley, yard or exit court. The door or window shall be operable from the inside to provide a full clear opening without the use of separate tools.

All escape or rescue windows shall have a minimum net clear openable area of 5.7 square feet. The minimum net clear openable height dimension shall be twenty-four inches. The minimum net clear openable width dimension shall be twenty inches. When windows are provided as a means of escape or rescue they shall have a finished sill height not more than forty-four inches above the floor. This measurement is taken from the floor to the clear opening of the window, not the lower window sill. The minimum net clear opening can be 5.0 square feet for grade-floor openings.

Formula for calculating openable area: **Height x Width (in inches) ÷ 144 = _____ sq. ft.**



Minimum Width and Height Requirements for Emergency Escape and Rescue Windows:

| | | | | | | | | | | | | | | | |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Width | 20 | 20.5 | 21.5 | 21.5 | 22 | 22.5 | 23 | 23.5 | 24 | 24.5 | 25 | 25.5 | 26 | 26.5 | 27 |
| Height | 41 | 40 | 39.1 | 38.2 | 37.3 | 36.5 | 35.7 | 34.9 | 34.2 | 33.5 | 32.8 | 32.2 | 31.6 | 31 | 30.4 |
| Width | 27.5 | 28 | 28.5 | 29 | 29.5 | 30 | 30.5 | 31 | 31.5 | 32 | 32.5 | 33 | 33.5 | 34 | 34.2 |
| Height | 29.8 | 29.3 | 28.8 | 28.3 | 27.8 | 27.4 | 26.9 | 26.5 | 26.1 | 25.7 | 25.3 | 24.9 | 24.5 | 24.1 | 24 |

LIGHT, VENTILATION AND SANITATION

All habitable rooms shall have a glazing area of not less than 8 percent of the floor area. Natural ventilation shall be through windows, doors, louvers or other approved openings to outdoor air. The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.

Adjoining rooms. For the purpose of determining light and ventilation requirements, any room shall be considered as a portion of an adjoining room when at least one-half of the area of the common wall is open and unobstructed and provides an opening of not less than one-tenth of the floor area of the interior room but not less than 25 square feet.

Bathrooms. Bathrooms, water closet compartments and other similar rooms shall be provided with glazing area of not less than 3 square feet, one-half of which must be openable. (*Exception*) The glazed area shall not be required where artificial light and a mechanical ventilation system are provided.

Required heating. Every dwelling unit shall be provided with heating facilities capable of maintaining a minimum room temperature of 68 degrees.

CEILING HEIGHTS

Minimum height. Habitable space, hallways, bathrooms, laundry rooms shall have a ceiling height of not less than 7 feet.

ROOM AREA

Dwelling units and congregate residences shall have at least one room that is at least 120 square feet in area. Other habitable rooms, except kitchens, must have a minimum area of at least 70 square feet.

WIDTH

No habitable room, other than a kitchen, may be less than seven feet in any dimension. Alcoves and entryways having dimensions less than seven feet are allowed within rooms but cannot be included when calculating the minimum area of the room. Kitchens shall have a clear passageway of not less than three feet between counters fronts and walls.

SMOKE ALARMS / CARBON MONOXIDE ALARMS

Smoke Alarms. Dwelling units and sleeping units shall be provided with smoke alarms. Alarms shall be installed in accordance with the manufacturer's installation instructions. An alarm shall be installed in each sleeping room and at a point centrally located to the area giving access to each separate sleeping room. When the dwelling has more than one story, an alarm shall be installed on each story. When sleeping rooms are on an upper level, the alarm shall be placed at the ceiling of the upper level in close proximity to the stairway.

Carbon Monoxide Alarms. An approved carbon monoxide alarm shall be installed in dwelling units and in sleeping units within which fuel-burning appliances are installed and in dwelling units that have attached garages. The carbon monoxide alarm shall be installed outside of sleeping areas in the immediate vicinity of the bedrooms and on every level.

Power Source. For new construction, required alarms shall receive their primary power from the building wiring and shall be equipped with a battery backup. The alarm shall emit a signal when the batteries are low. Alarms may be solely battery operated when installed in existing buildings.

Interconnection. Where more than one hard wired alarm is required to be installed, the alarms shall be interconnected in a manner that activation of one alarm will activate all of the alarms.

ATTACHED GARAGES

The private garage shall be separated from the dwelling unit and its attic area by means of a minimum 1/2-inch gypsum board applied to the garage side. Garages beneath habitable rooms shall be separated with 5/8-inch type X gypsum for ceilings. Doors between a private garage and the dwelling shall be either solid wood doors or honeycomb core steel doors not less than 1 3/8 inches thick. No openings from a garage directly into a room used for sleeping purposes allowed. Doors shall be self-closing and self-latching. Ducts in private garage and ducts penetrating the walls or ceilings separating the dwelling unit from the garage shall be constructed of a minimum 0.019-inch sheet steel (26 gage steel) and shall have no openings into garage. **Fire dampers** can no longer be used as a means of installing flex duct in exposed areas of garage.

Garage floor surfaces shall be of approved noncombustible material. The area of floor used for parking vehicles shall be sloped to facilitate the movement of liquids to a drain or toward the main vehicle entry doorway.

ATTACHED CARPORTS

An occupancy separation need not be provided between a residence and a carport having no enclosed uses above, provided the carport is entirely open on two or more sides.

DETACHED GARAGES AND ACCESSORY BUILDINGS

Any structure less than three feet from a property line must have a one hour fire wall along that side and no openings (windows, doors, etc.) are permitted in this wall. Detached structures must be a minimum of six feet from any other structure. This distance is measured from face of support to face of support.

City Planning and Building Divisions criteria are considered when deciding how close you can build to a property line. Building setback lines may require greater distances from property lines than California Building Code regulations allow.

An accessory structure less than 120 square feet does not require a permit provided that it meets all requirements listed:

- Lot coverage and setback requirements apply to all accessory structures.
- The maximum height of any accessory structure is 9 feet for walls and 14 feet maximum roof peak height.
- Only one accessory structure not requiring a permit can be located on a property.
- Electrical and plumbing permits are required regardless of the size of the structure.

WINDOW AND DOOR REPLACEMENT

A building permit is required for the installation or replacement of any window or patio door. Replacement of broken glass does not require a building permit. All new windows and doors must meet current Building and Energy Code requirements. Windows and doors shall be installed and flashed in accordance with the manufacture's installation instructions. The written installation instructions provided by manufacturer are to be available for the inspector at the time of inspection.

WINDOW SILL HEIGHT

Where the opening portion of an openable window is located more than 72" above the exterior finish grade (usually windows above first level) the window must be at least 24" above interior finished floor of the room, or the openable section of window shall not allow passage of a 4" sphere. (**Exception**) Openings that are provided with approved fall prevention devices or limiting devices would be allowed.

GLAZING HAZARDOUS LOCATIONS

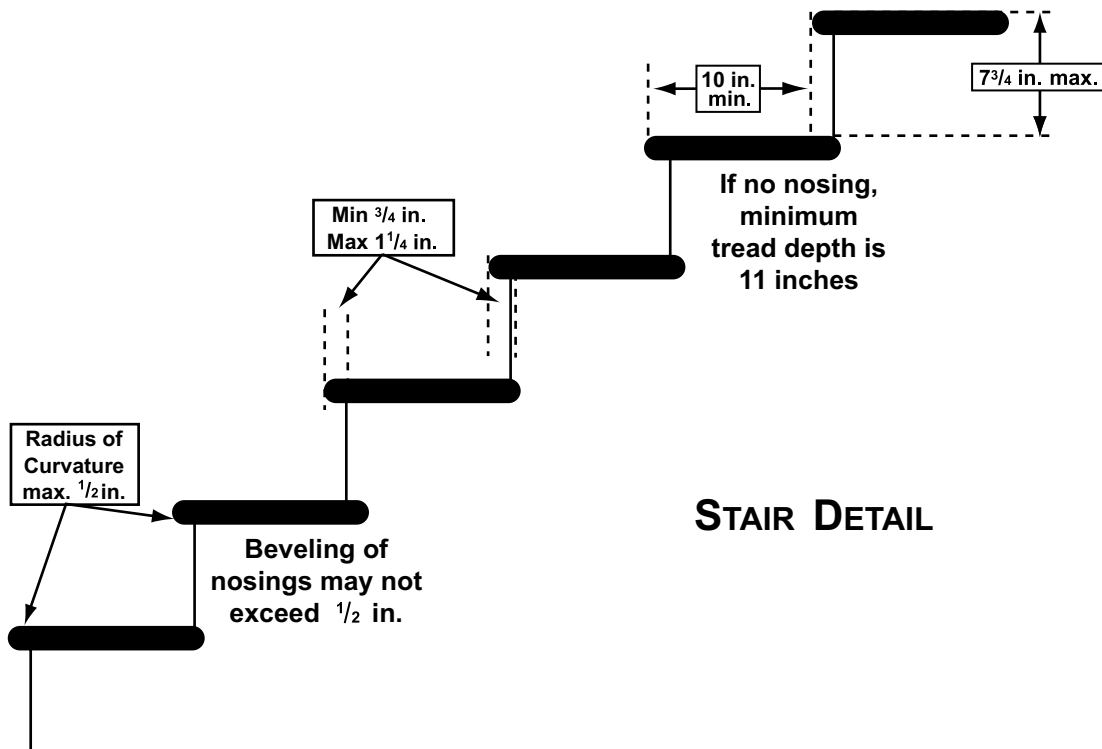
These areas require safety glazing that meets code requirements for human impact and identification.

1. Glazing in all fixed and operable panels of swinging, sliding and bifold doors.
(Exceptions: Glazed openings less than 3"- Decorative glazing)
2. Glazing in an individual fixed or operable panel adjacent to a door where the nearest vertical edge is within a 24" arc of the door in a closed position and bottom edge is less than 60" above the floor.
(Exceptions: *Decorative glazing – Where there is a permanent barrier between the door and the glazing – Glazing in walls on the latch side of and perpendicular to the plane of the door in the closed position*)
3. Glazing in an individual fixed or operable panel that meets all of the following conditions: The exposed area of an individual pane is larger than 9 square feet, and the bottom edge of the glazing is less than 18 inches above the floor, and the top edge of the glazing is more than 36 inches above the floor, and walking surface is within 36 inches of glazing.
4. All glazing in railings regardless of area or height above walking surface.
5. Glazing in enclosures for or walls facing hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers where the exposed edge of the glazing is less than 60 inches above any standing or walking surface.
(Exceptions: *Glazing that is more than 60 inches from the waters edge of a hot tub, whirlpool or bathtub*)
6. Glazing in walls and fences adjacent to indoor and outdoor swimming pools, hot tubs and spas where the bottom edge of the glazing is less than 60 inches above a walking surface and within 60 inches of the water's edge.
7. Glazing adjacent to stairways, landings and ramps within 36 inches of a walking surface when the exposed surface of the glazing is less than 60 inches above walking surface.
8. Glazing adjacent to stairways within 60 inches horizontally of the bottom tread of a stairway in any direction when the exposed surface of the glazing is less than 60 inches above the nose of the tread.

STAIRWAYS AND LANDINGS

Private stairways shall be a minimum of 36 inches wide. Trim and handrails may not encroach into this minimum width by more than 4 1/2 inches. The maximum rise of each step is 7 3/4 inches, the minimum rise is 4 inches. The minimum run is 10 inches. If there is no nosing minimum tread depth is 11 inches. The largest tread width or riser height in any flight of stairs shall not exceed the smallest by more than 3/8 inch. A nosing not less than 3/4 inch but not more than 1 1/4 inches shall be provided on stairways with solid risers where the tread depth is less than 11 inches. The radius or bevel at the leading edge of the stair tread shall be 1/2 inch maximum.

For residential stairs, open risers are permitted, provided that the opening between treads does not permit the passage of a 4-inch diameter sphere.



Every stairway must have a headroom clearance of not less than 6'8" measured vertically from the tread nosing to the horizontal plane above.

Enclosed useable space under stairs must be protected on the enclosed side by 1-hour fire rated construction.

Landings must have a width and a dimension measured in the direction of travel not less than the width of the stairway. Doors in the fully open position shall not reduce a required dimension by more than 7 inches.

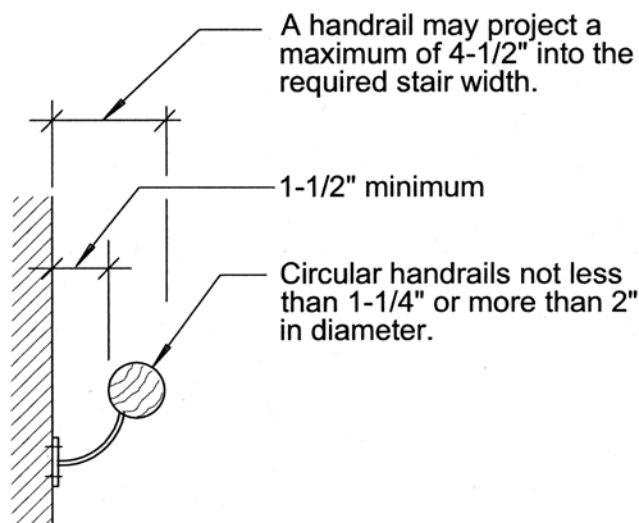
The main exterior door shall have a landing immediately on the exterior side. These landings shall be as wide as the door and a minimum of 36 inches in the direction of travel. These landings must be no more than 7 3/4 inches below the interior floor level.

An **interior** door at the top of a flight of stairs need not have a landing at the top of the stairs, provided the door swings away from the stairs.

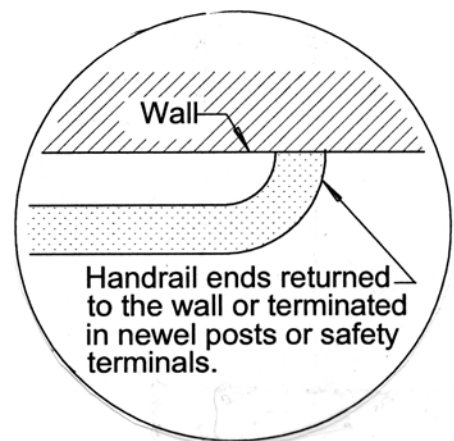
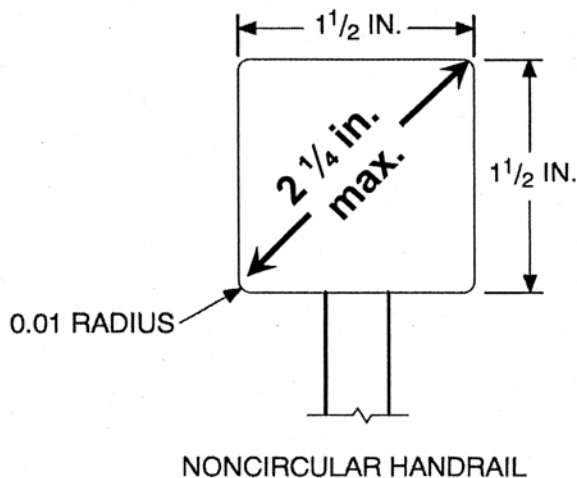
HANDRAILS

The intent of a handrail is to provide a handgrip for people using a stairway. Stairways, which serve an individual dwelling unit, must have a handrail on one side if they have four risers or more. Handrails projecting from a wall shall have not less than 1 1/2 inches between the wall and handrail. Handrails must be placed between 34 and 38 inches above the nosing of the stair treads. Ends must be returned or have rounded terminations or bends. The handgrip portion of handrails shall not be less than 1 1/4 inches nor more than 2 inches in cross-sectional dimension or the shape shall provide an equivalent gripping surface. The handgrip portion of handrails shall have a smooth surface with no sharp corners.

Handrails that are not circular must have a perimeter of 4 inches minimum and 6 1/4 inches maximum with a maximum cross-section dimension of 2 1/4 inches.



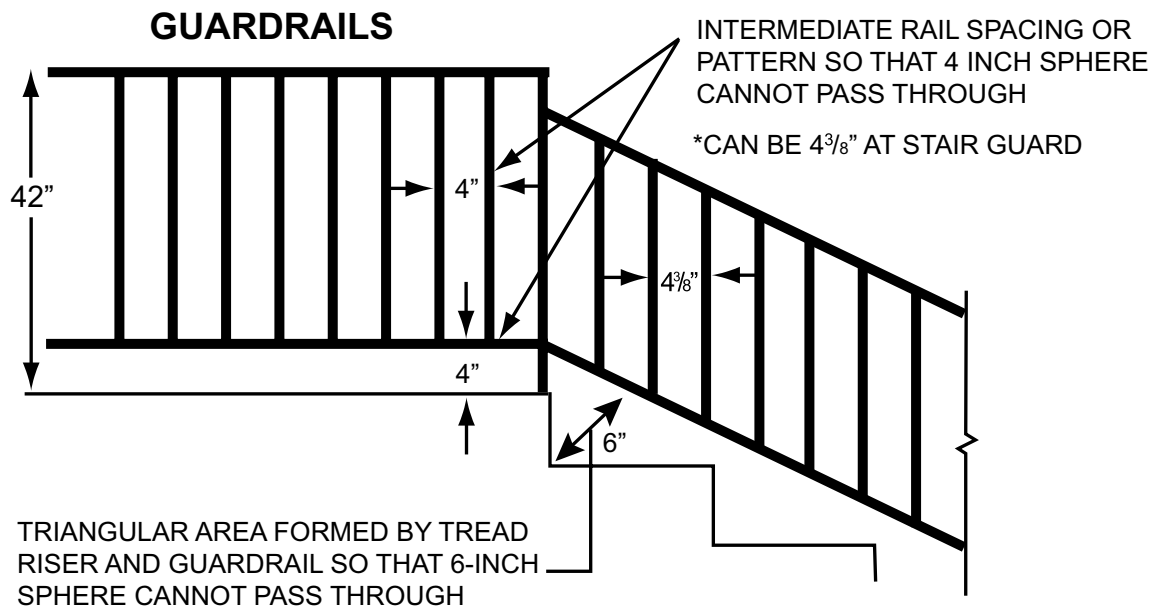
Handrail that is not circular must have a perimeter of 4 in. min & 6 1/4 max with a max cross-section dimension of 2 1/4 in.



GUARDS

The intent of a guardrail is to prevent people, particularly small children, from falling off the edge of a horizontal standing surface. Guards shall protect open sides of stairways, landings, ramps, balconies, decks, or porches, which are more than 30 inches above grade or the floor below.

The top of residential guardrails must be at least 42 inches above the upper standing surface. Guardrails must have intermediate rails or an ornamental pattern placed in such a manner that a sphere 4 inches in diameter cannot pass through. The triangular openings formed by the riser, tread and bottom element of a guardrail at the open side of a stairway may be of such size that a sphere 6 inches in diameter cannot pass through. Openings for required guards on the sides of stair treads shall not allow a sphere of $4\frac{3}{8}$ inches to pass through.



FOOTINGS AND FOUNDATIONS

Prior to pouring any concrete, the bottom of the footings must be cleaned out, removing any loose soil, wood, or debris. Roots must also be removed. All reinforcing steel must be held away from contact to soil or forms. (Note: The use of steel bars driven into the ground to support rebar is prohibited.) 3 inches of clearance is required from reinforcing bars to sides and bottom of earth-formed footings, and 1 1/2 inches clearance is required from #5 and smaller reinforcing bars to forms.

Wood forms located in the ground, or between the foundation sills and the ground, must be removed after pouring concrete.

Reinforcing steel when spliced must have a minimum lap of twenty inches for #4 (1/2 inch) bars and twenty-five inches for #5 (5/8 inch) bars. Where a new footing intersects an existing footing the new reinforcing must be doweled at least six inches into the existing footing.

FOUNDATIONS

All exterior footings shall be at least 12 inches below undisturbed ground surface. Foundations with stem walls shall have a minimum of one #4 bar within 12 inches of the top of wall and one #4 bar located 3 to 4 inches from bottom of footing. Slabs on ground with turned down footings shall have a minimum of one #4 bar at the top and the bottom of footing.

SLABS ON GRADE

Concrete slabs supported directly on the ground may not be less than 3 1/2 inches thick. A continuous footing is required; see foundation details for examples. Any reinforcement in slabs on grade must have two inches of clearance from soil. A vapor barrier of six-mil polyethylene with any joints lapped 6 inches minimum is required for habitable space.

SURFACE DRAINAGE

Surface drainage shall be diverted to a storm drain or an area that can absorb the water. Lots shall be graded to drain surface water away from foundation walls. The slope away from foundation should be 6-inches minimum within the first 10-feet. Where it is not possible to obtain minimum slope, drains, or swales shall be constructed to ensure drainage away from structure.

Impervious surfaces within 10-feet of the building foundation shall be sloped a minimum of 2-percent away from the building.

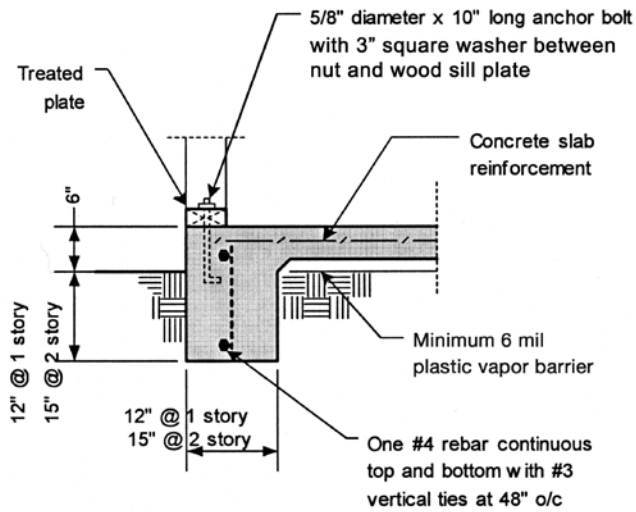
FOUNDATION DRAINAGE

Drains shall be provided around all foundations that retain earth and enclose any usable space located below grade. An approved system shall be installed in the area to be protected and shall discharge by gravity or mechanical means into an approved drainage system.

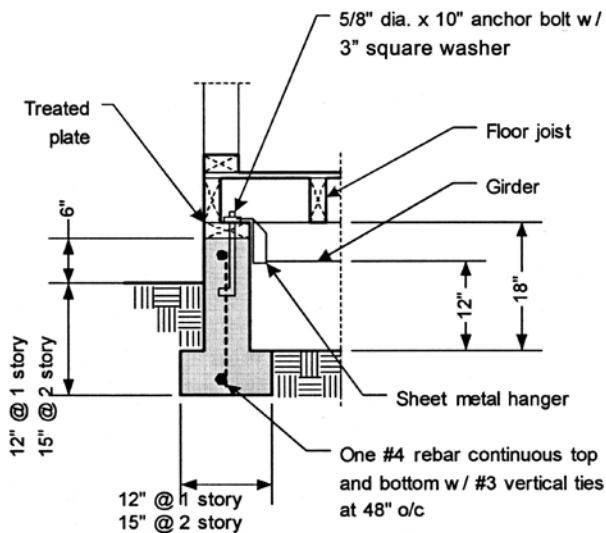
FOUNDATION WATERPROOFING AND DAMPPROOFING

Exterior foundation walls that retain earth and enclose interior spaces and floors below grade shall be waterproofed in accordance with a system approved by the building code.

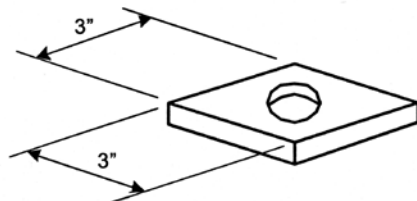
TYPICAL RESIDENTIAL FOUNDATIONS DETAILS



Typical Footing - Concrete Floor

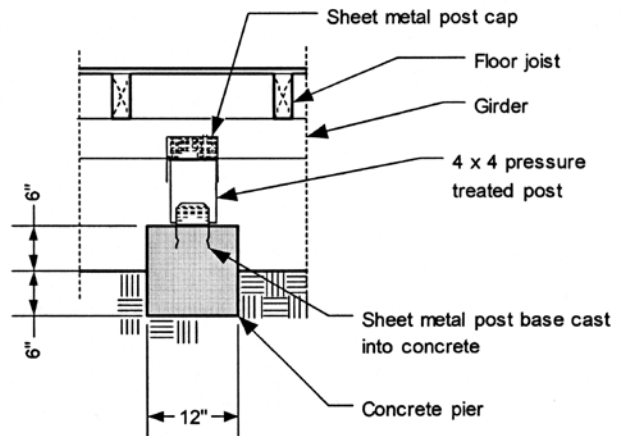


Typical Footing - Raised Wood Floor

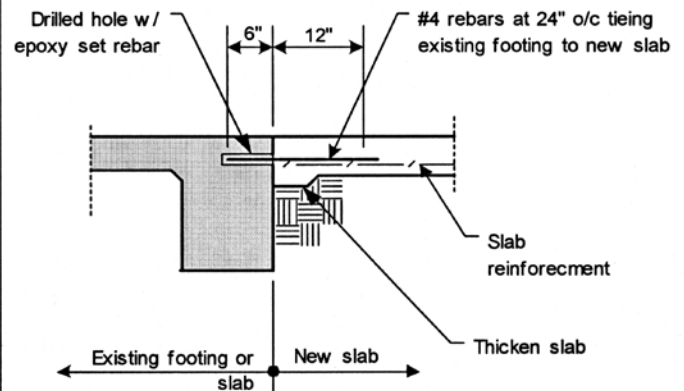


5/8" x 10" Bolt for 2" x sill
5/8" x 12" Bolt for 3" x sill

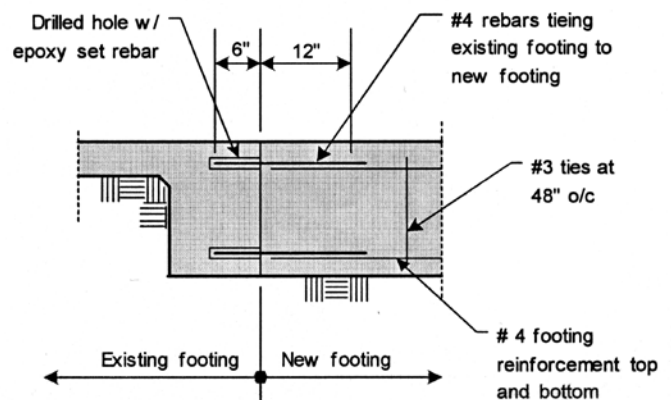
Anchor Bolt Washer Dimensions



Typical Pier - Raised Wood Floor



Existing to New Concrete Slab Tie



Existing to New Concrete Footing

FLOOR JOISTS, GIRDERS AND POSTS

For details on attachment of the mudsill to the foundation, see the section on SILL PLATES under **WALL FRAMING**.

When wood floor joists or the bottom of wood structural floors without joists are located closer than 18 inches or wood girders are located closer than 12 inches to exposed ground, the floor assembly, including posts, girders, joists, and subfloor, shall be pressure treated wood.

The bottoms of posts supporting girders must be at least 6 inches above earth unless they are pressure treated. This is usually done with piers.

Girder splices must occur over posts and must be provided with an adequate tie, such a metal bracket or strap.

The ends of each joist shall have at least 1 1/2 inches of bearing on wood or metal. Where joists bear directly on concrete or masonry, they must have at least 3 inches of bearing.

Solid 2X nominal blocking is required at ends of joists and over all bearing points. Blocking may be omitted where ends of joists are nailed to a header or rim joist.

Joists framing from opposite sides of a beam, girder or partition shall be lapped at least three inches or the opposing joists shall be tied together in an approved manner. Blocking does not meet this requirement.

Notches on ends of joists must not exceed 1/4 the depth of the joist. Other notches in the top or bottom of joists must not exceed 1/6 the joist depth and must not be located in the middle 1/3 of the joist span.

Holes bored in joists must not be within two inches of the top or bottom and the diameter must not exceed 1/3 of the joist depth.

Trimmer and header joists at openings must be doubled when the header span exceeds 4 feet.

UNDERFLOOR VENTILATION AND ACCESS

Underfloor areas must be ventilated by openings in the exterior foundation walls. The openings must have a net area of 1 square foot for each 150 square feet of under floor area and should be located to provide cross ventilation. Openings must be screened with corrosion resistant wire mesh with openings of 1/8-inch minimum. All underfloor areas must have an access opening at least 18" x 24". Ducts and other obstructions cannot block access to any portion of the under floor area.

PLYWOOD SUBFLOORING

Plywood floor nailing is required to be 6 inches on center on all edges and 12 inches on center on intermediate supports. The thickness of plywood will be determined by your joist spacing and the panel identification index of plywood selected for use. All plywood flooring edges must have tongue and groove joints or be supported with blocking.

WALL FRAMING

SILL PLATES

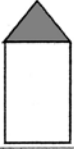

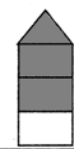

Studs shall have full bearing on a plate or sill not less than 2 inches in nominal thickness and having a width not less than that of the wall studs.

Exterior sill plates bearing on concrete must be pressure treated lumber. Foundation plates or sills bearing on concrete foundations shall be bolted to foundation with a minimum of 10 inch long steel bolts embedded at least 7 inches into the concrete. Bolts must not be spaced over 6 feet apart. A minimum of two bolts are required per piece. Bolts must be located no more than 12 inches and no less than 4 inches from each end of each piece. Each bolt must have a 3" x 3" square washer under the nut.

STUDS

The size, height and spacing of studs shall be in accordance. Studs shall be placed with their wide dimension perpendicular to the wall. At least three studs need to be installed at each corner of an exterior wall.

SIZE, HEIGHT AND SPACING OF WOOD STUDS^a

| STUD SIZE (inches) | BEARING WALLS | | | | | NONBEARING WALLS | |
|-----------------------|--|--|---|--|---|---|--------------------------------|
| | Laterally unsupported stud height ^a (feet) | Maximum spacing when supporting a roof-ceiling assembly or a habitable attic assembly, only (inches) | Maximum spacing when supporting one floor, plus a roof-ceiling assembly or a habitable attic assembly (inches) | Maximum spacing when supporting two floors, plus a roof-ceiling assembly or a habitable attic assembly (inches) | Maximum spacing when supporting one floor height ^a (feet) | Laterally unsupported stud height ^a (feet) | Maximum spacing (inches) |
| | |  |  |  |  | | |
| 2 x 3 ^b | — | — | — | — | — | 10 | 16 |
| 2 x 4 | 10 | 24 ^c | 16 ^c | — | 24 | 14 | 24 |
| 3 x 4 | 10 | 24 | 24 | 16 | 24 | 14 | 24 |
| 2 x 5 | 10 | 24 | 24 | — | 24 | 16 | 24 |
| 2 x 6 | 10 | 24 | 24 | 16 | 24 | 20 | 24 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.093 m².

- a. Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Increases in unsupported height are permitted where justified by analysis.
- b. Shall not be used in exterior walls.
- c. A habitable attic assembly supported by 2 x 4 studs is limited to a roof span of 32 feet. Where the roof span exceeds 32 feet, the wall studs shall be increased to 2 x 6 or the studs shall be designed in accordance with accepted engineering practice.

TOP PLATES

Bearing and exterior wall studs shall be capped with a double top plate installed to provide overlapping at corners and intersections with other walls. End joints in double top plates must be offset by at least 4 feet and the lap must be nailed together with at least 8 – 16d nails.

CRIPPLE WALLS

Foundation cripple walls shall be framed of studs not less in size than the studding above with a minimum length of 14 inches, or shall be framed with solid blocking. For seismic category D or E, cripple walls having a stud height exceeding 14 inches shall be considered a story and shall be braced as required for braced wall lines in accordance with table 2308.12.4

FIRE BLOCKING

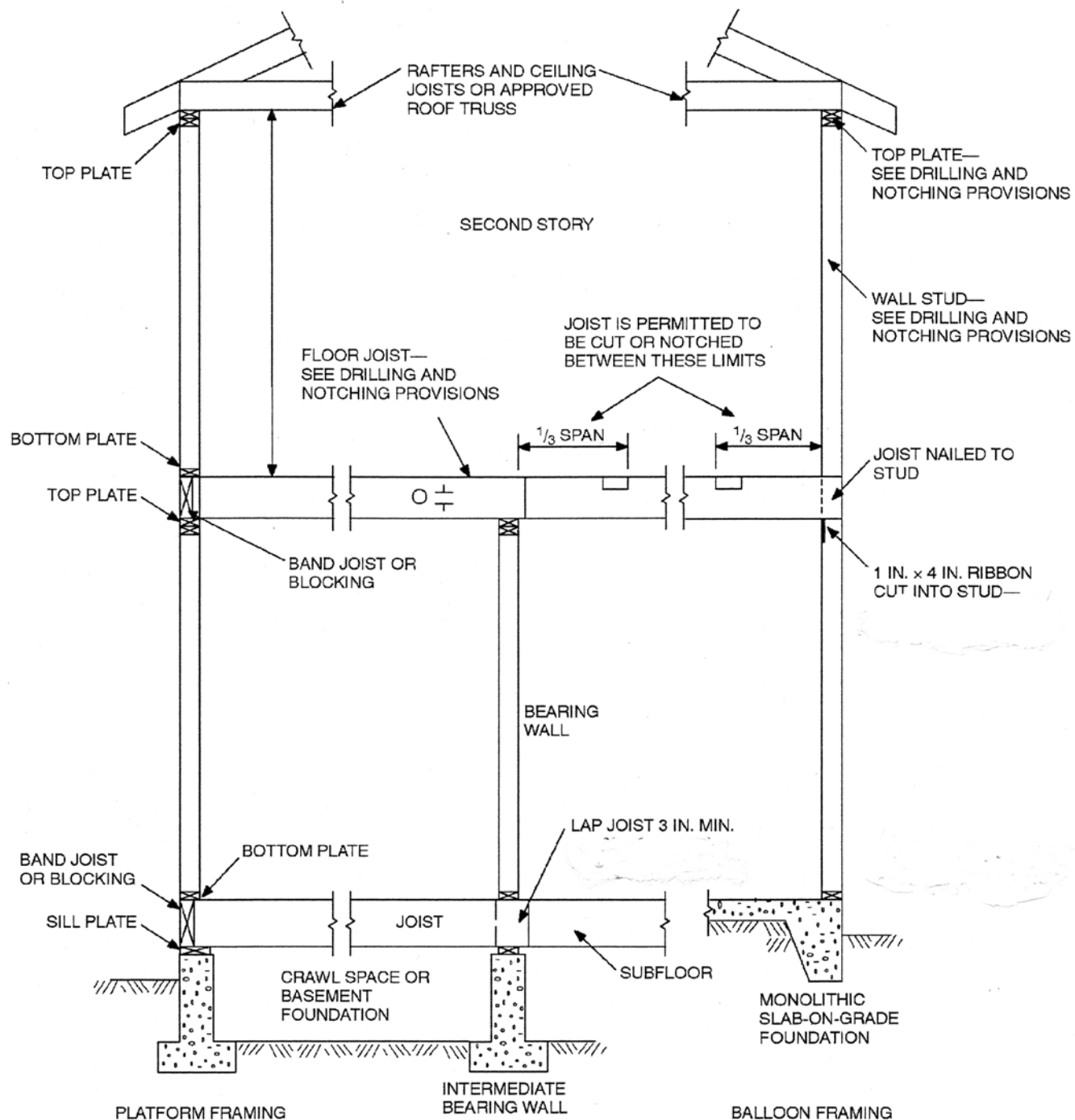
Fire blocking is required in all stud walls at ceilings and floor levels. The vertical distance between blocking shall not exceed ten feet. It is also required where a ceiling is below the top plate of the wall such as soffit ceilings, and around the edges of tubs and showers on wood floors. Holes for pipes that pass from one floor level to another or into an attic space must have the openings fire stopped with non-combustible material. Where insulation batts are used as fire blocking between studs, they must be stapled in place.

STRUCTURAL WOOD PANEL WALL SHEATHING

Nails or other approved fasteners shall be driven flush but shall not fracture the surface of the structural wood panel. If more than 20% of the fasteners are over driven by more than 1/8", additional fasteners shall be driven to maintain the required shear capacity. If the condition of close nailing pattern does not allow for additional fasteners without concern of splitting framing members, the engineer of record shall be required to provide a wet stamped letter with specific directions for correction.

Nails shall be placed not less than 3/8" in from the panel edge, shall be spaced six inches on center along panel edge, some shearwalls required tighter nail spacing.

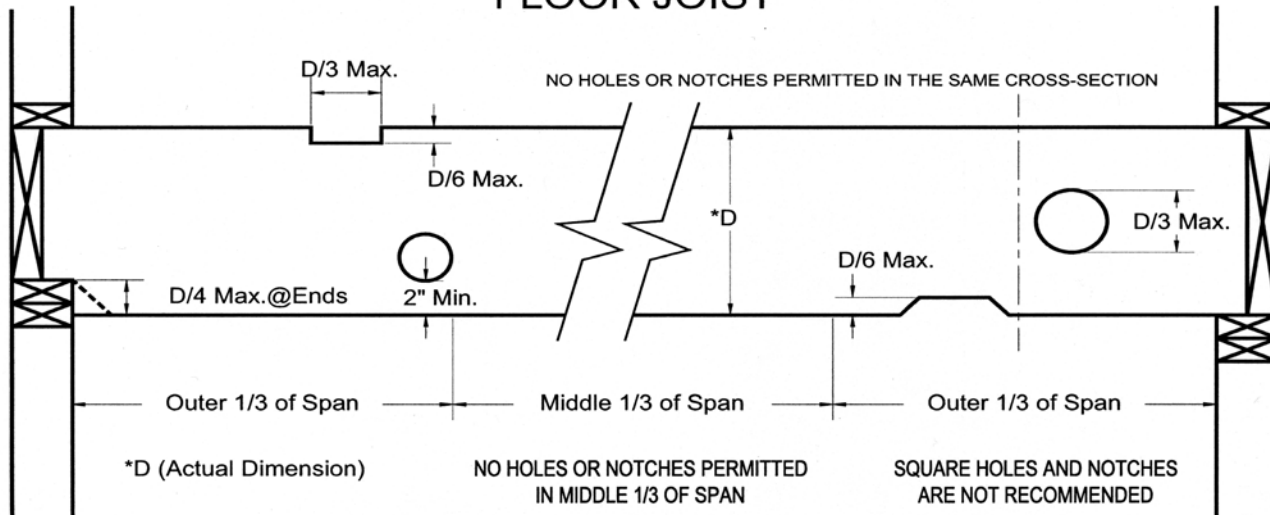
Framing members or blocking shall be provided at the edges for all Braced Wall Panels and shearwalls.



TYPICAL WALL, FLOOR AND ROOF FRAMING

NOTCHING, CUTTING, AND BORING GUIDE

FLOOR JOIST



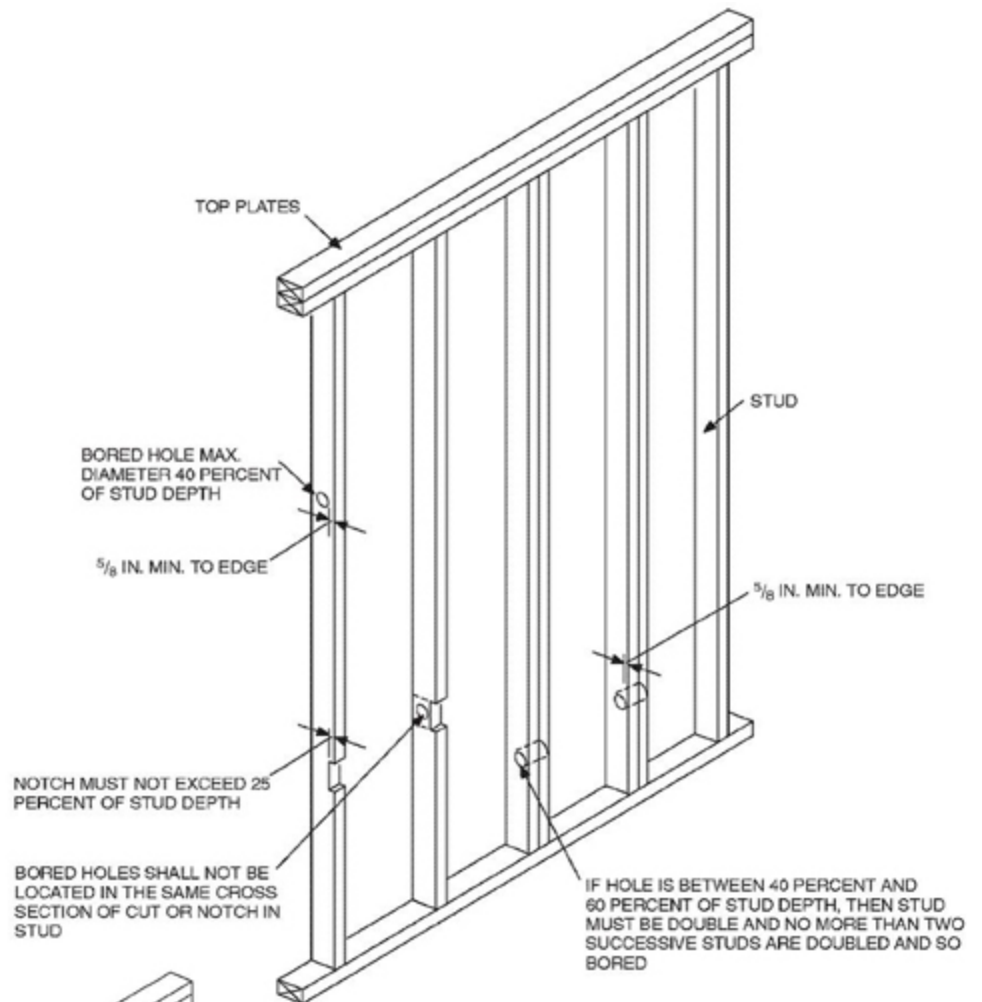
CUTS, NOTCHES AND BORED HOLES FOR PIPING

Where plumbing, heating or other pipes are run through the top or bottom plates of walls and these plates are cut partially or totally through, they must have a 1 1/2" wide 16 gauge metal tie fastened across them with six 16d nails on each side of the opening. Studs in exterior walls and bearing walls must not be cut or notched more than 25 percent of their width (i.e., 7/8" for 2 x 4's or 1 3/8" for 2 x 6's). Cutting or notching up to forty percent of stud width is permitted in non-bearing partitions.

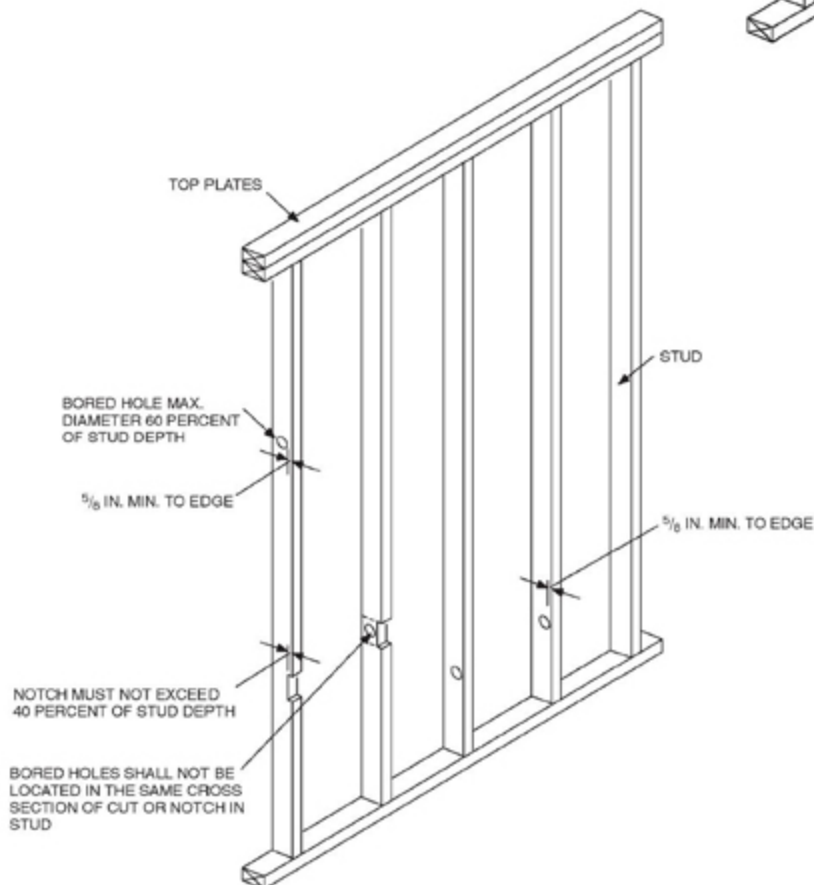
A bored hole not exceeding forty percent of the stud width (i.e., 1 3/8" for a 2 x 4 or 2 1/4" for a 2 x 6) may be made in any stud provided the edge of the hole is no nearer to the face of the stud than 5/8". If holes up to sixty percent of the width of the stud are made, the wall studs must be doubled, and no more than two successive studs can be bored. Holes up to sixty percent of the stud width can be made in non-bearing walls without doubling (i.e., 2 1/8" for a 2 x 4, and 3 1/4" for a 2 x 6).

| Joist Size | Max. Hole | Max. Notch Depth | Max. End Notch |
|------------|-----------|------------------|----------------|
| 2x4 | NONE | NONE | NONE |
| 2X6 | 1-1/2" | 7/8" | 1-3/8" |
| 2X8 | 2-3/8" | 1-1/4" | 1-7/8" |
| 2X10 | 3" | 1-1/2" | 2-3/8" |
| 2X12 | 3-3/4" | 1-7/8" | 2-7/8" |

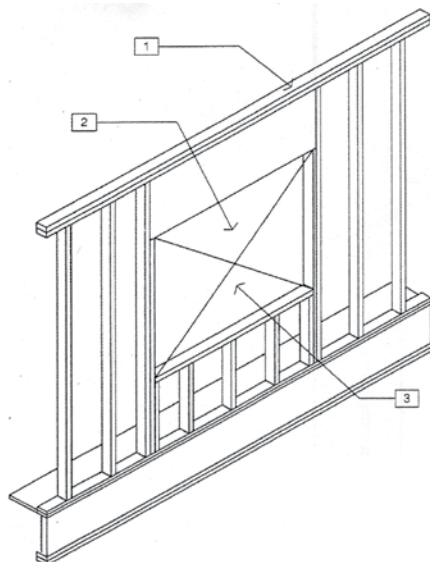
NOTCHING AND BORED HOLE LIMITATIONS FOR EXTERIOR WALLS AND BEARING WALLS



NOTCHING AND BORED HOLE LIMITATIONS FOR INTERIOR WALLS AND NONBEARING WALLS



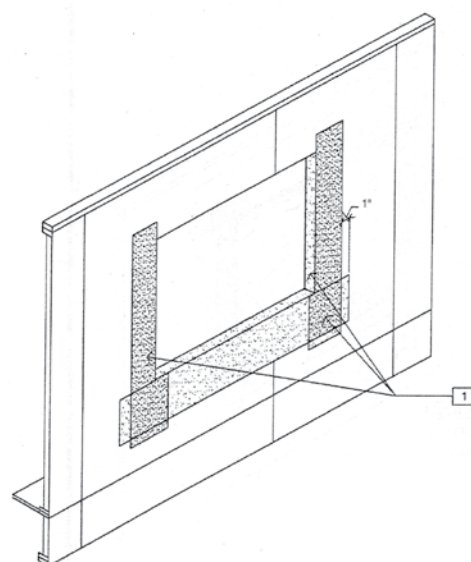
NAIL ON FIN WINDOW FLASHING



LEGEND

1. SQUARE & LEVEL FRAMING.
2. ROUGH WINDOW OPENING.
3. ROUGH FRAMED OPENING SUFFICIENTLY LARGER IN WIDTH & HEIGHT THAN THE ACTUAL FRAME DIMENSIONS OF THE WINDOW. TO ASSURE ADEQUATE CLEARANCE CONSULT THE WINDOW MANUFACTURER'S LITERATURE FOR THE RECOMMENDED ROUGH OPENING DIMENSIONS.

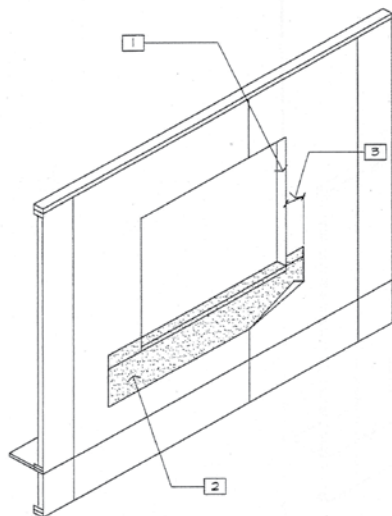
ROUGH WINDOW OPENING



LEGEND

- JAMB FLASHING FLUSH AT BOTH SIDES OF OPENING LEAVING FREE AT BOTTOM, (WRAP JAMB FLASHING INTO ROUGH OPENING AT RECESSED WINDOWS ONLY, SIMILAR AT SILL). EXTEND BEYOND SILL FLASHING ABOVE WHERE HEAD FLASHING WILL INTERSECT. LAP JAMB FLASHING OVER TOP SILL FLASHING. LEAVE PAPER FLASHING UNATTACHED FROM SILL DOWN.

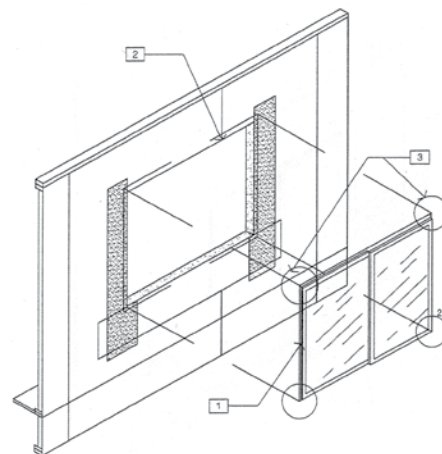
JAMB FLASHING



LEGEND

1. WALL SHEATHING (WHERE OCCURS), VERIFY SHEATHING EDGES FLUSH WITH FRAME OPENING AND COMPLETION OF STRUCTURAL NAILING & REINFORCEMENT BEFORE PROCEEDING.
2. APPLY 12" "MOISTOP" OR APPROVED EQUIVALENT SILL FLASHING HORIZONTALLY BELOW THE SILL. (WRAP FLASHING INTO ROUGH OPENING AT SILL & JAMB CONDITIONS TO PROTECT FRAMING. FASTEN THE TOP EDGE OF THE SILL FLASHING TO THE FRAMING, BUT DO NOT FASTEN THE LOWER EDGE, SOO WEATHER RESISTANT BUILDING PAPER APPLIED LATER MAY BE SLIPPED UP UNDERNEATH THE FLASHING IN WEATHER BOARD FASHION.
5. EXTEND "MOISTOP" OR APPROVED EQUIVALENT SILL FLASHING HORIZONTALLY 1" BEYOND VERTICAL JAMB FLASHING APPLIED LATER.

SILL FLASHING



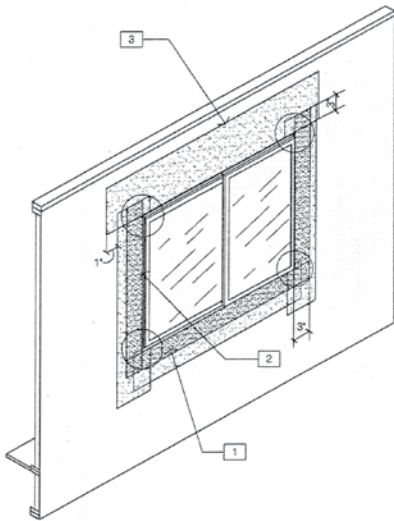
1. SHIM & ADJUST WINDOW TO ACHIEVE SQUARE PLUMB & LEVEL CONDITION. USE CORROSION RESISTANT FASTENERS. FASTEN WITHIN 10" AND NO CLOSER THAN 3" IN EACH DIRECTION FROM EVERY CORNER. SECURE WINDOW HEAD W/ 6d FASTENERS 1/2" ABV. TOP OF WINDOW FINISH. BEND NAIL O/ FLANGE FLAT. REFER TO MFG'S INSTRUCTIONS REGARDING NAIL FIN ATTACHMENT.

2. TO SEAL THE WINDOW FRAME TO OPENING, APPLY CONTINUOUS SEALANT TO THE BACKSIDE OF THE MOUNTING FLANGE NEAR THE OUTER EDGE AND APPLY CONTINUOUS SEALANT TO PERIMETER OF OPENING AT A POINT TO ASSURE CONTACT WITH BACKSIDE OF MOUNTING FLANGE WITH IN 1/2" OF EDGE OF OPENING.

3. AFTER INSTALLATION SEAL ALL CORNERS OF MECHANICALLY JOINT FRAMES TO SEAL FRAME SEAM JUNCTURE.

WINDOW INSTALLATION

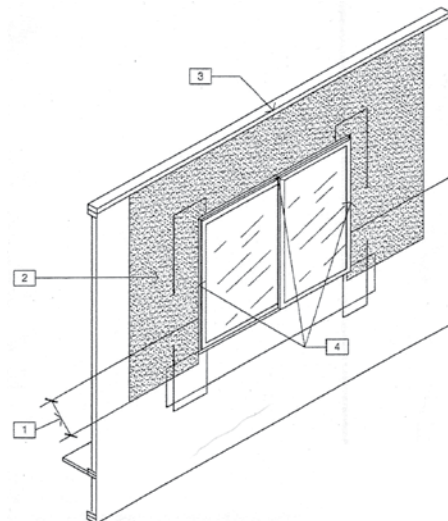
NAIL ON FIN WINDOW FLASHING



LEGEND

1. APPLY 6" SELF-ADHERING "E-2 SEAL" MEMBRANE OVER "MOISTOP" AND 3" BEYOND WINDOW FLANGE.
2. APPLY 6" "E-Z SEAL" MEMBRANE AT JAMBS OVER "MOISTOP". EXTEND 3" BEYOND WINDOW FLANGE.
3. APPLY 12" "E-Z SEAL" MEMBRANE AT HEADER OF WINDOW. EXTEND 1" BEYOND "MOISTOP".
4. APPLY FIRM PRESSURE TO SELF-ADHERING MEMBRANE TO ASSURE ADHERENCE TO WINDOW FIN.
5. CHECK ALL CORNERS FOR PROPER SEAL OF SELF-ADHERING MEMBRANE.

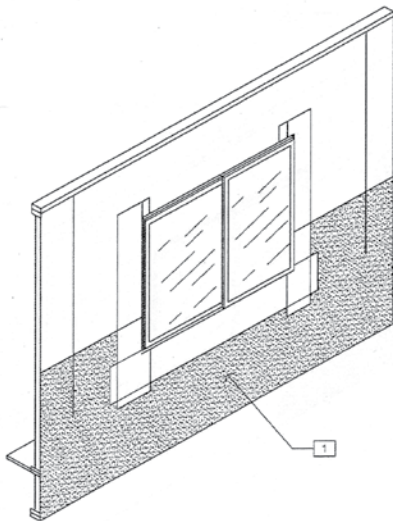
SELF ADHESIVE MEMB.



LEGEND

1. 6" MIN VERTICAL LAP FOR ALL HORIZONTAL & VERTICAL JOINTS IN BUILDING PAPER.
 2. LAP SUBSEQUENT COURSES OVER "MOISTOP".
 3. CARRY PAPER TO UPPER EDGE OF TOP PLATE
 4. HOLD PAPER BACK 1" FROM WINDOW.
- BUILDING- PAPER- SECOND COURSE

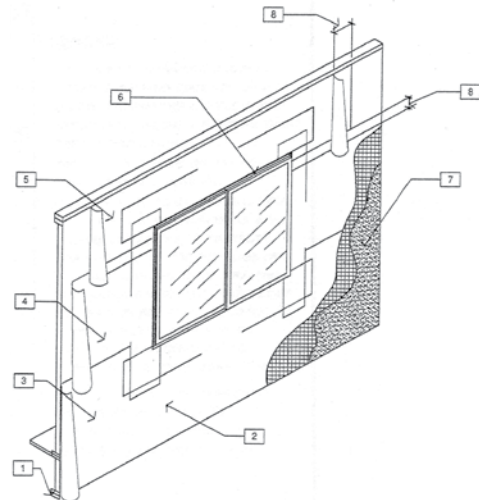
BUILDING PAPER - SECOND COURSE



LEGEND

1. INSERT FIRST COURSE OF 60 MIN. PAPER UNDER "MOISTOP" AND STAPLE "MOISTOP"

BUILDING PAPER - FIRST COURSE



LEGEND

1. STUCCO WEEP SCREED, WHERE REQD.
2. INSTALL SECOND LAYER OF 60 MIN. PAPER OVER EVERYTHING, WHERE REQD
3. FIRST COURSE OF BUILDING PAPER. 18" IN HEIGHT.
4. SECOND COURSE OF BUILDING PAPER, 36-IN HEIGHT.
5. THIRD COURSE OF BUILDING PAPER, 36" IN HEIGHT
6. INSTALL WINDOW HEAD FLASHING PROTECTION LAYER LAPS OVER FLASHING FLANGE.
7. EXTERIOR WALL FINISH; INSTALL PER WALL FINISH MFG.'S RECOMMENDATION.
8. 6" VERTICAL HORIZONTAL LAPS.

TRIM FLASHING - PROTECTION COURSE

ROOF AND CEILING FRAMING

RAFTERS

Rafters must be framed directly opposite each other at the ridge and blocked over end bearing walls. The ridge board must be not less in depth than the plumb end of the rafter. Usually a ridge board one size bigger than the rafter will meet this requirement, but at some steeper pitches, a larger size may be required. Valley and hip rafters must be a minimum of 2X thickness and again not less in depth than the plumb end of the rafters.

RAFTERS TIES

Rafter ties that form a continuous tie between exterior walls are required on all roof framing. These ties may be the ceiling joists if parallel to the rafters or may be separate ties nailed to opposing rafters. Rafter tie spacing must not exceed four feet.

PURLINS

Rafter spans can be increased through the proper use of purlins as intermediate supports. Purlins must be supported by struts to bearing walls or properly designed beams. Purlins cannot be smaller than the supported rafter. 2 x 6 purlins may span a maximum of six feet. Struts used to support purlins may not be smaller than 2 x 4's. Struts must not exceed eight feet unbraced, and may not be installed at slopes lower than forty-five degrees from horizontal.

ROOF SHEATHING

Structural wood panel sheathing may be of intermediate or exterior grade except at exposed eaves where only exterior grade is permitted. Joints parallel to framing members must occur over framing members

CEILING FRAMING

Ceiling joists cannot be used to brace roof framing. Ceiling joists 2 x 6 and larger should be solidly blocked at ends unless nailed directly to rafters. Refer to the span tables for maximum allowable spans. Strongbacks are not given any credit when evaluating maximum span.

ATTIC VENTILATION AND ACCESS

Enclosed attics shall have cross ventilation. It is recommended that high (exhaust) and low (intake) ventilation be used. Where high and low ventilation is approximately equal, one square foot of ventilation for each three hundred square feet of attic area is required. Where high and low ventilation is not used one square foot per 150 square feet is required. Screen vents must be 1/4" mesh. Any attic with 30" or more of vertical height must be accessible through a minimum opening of 22" x 30".

ROOF COVERINGS

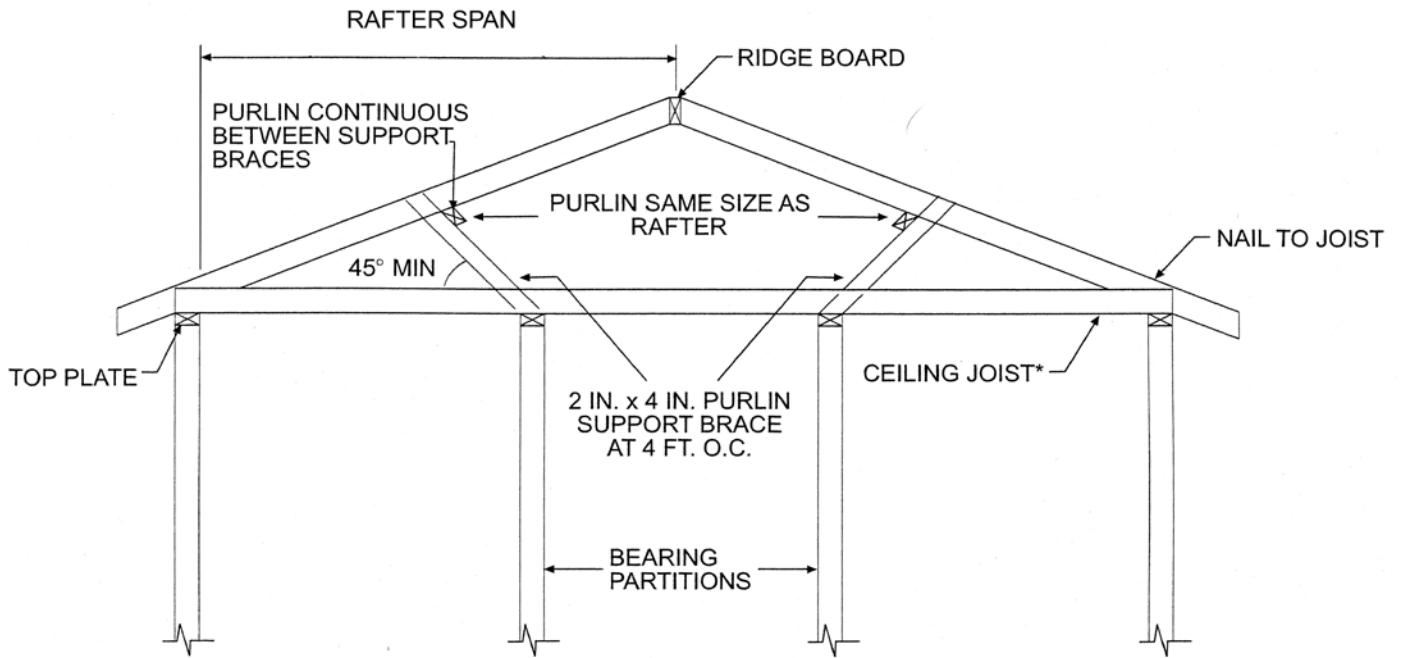
The City of San Bruno does not allow roof overlays. A complete tear off of all old roofing materials is required. Class B or better fire rating is required for roofing materials.

LOW SLOPE ROOFS

For roof slopes from 2 1/2" vertical in 12" horizontal, up to 4" vertical in 12" horizontal, underlayment for shingles shall be a minimum of two layer applied as follows:

1. Starting at the eave, a 19-inch strip of underlayment shall be applied parallel with the eave and fastened.
2. Starting at the eave, a 36-inch wide strip of underlayment shall be applied overlapping successive sheets 19-inches and fastened.

BRACED RAFTER CONSTRUCTION



MAXIMUM ALLOWABLE SPANS - 2010 CALIFORNIA RESIDENTIAL BUILDING CODE

FLOOR JOISTS -- 40# LL - Residential living areas, 40 psf live load

| | <u>12" o.c.</u> | <u>16" o.c.</u> | <u>19.2" o.c.</u> | <u>24" o.c.</u> |
|------------|-----------------|-----------------|-------------------|-----------------|
| 2x6 #2 DF | 10' 9" | 9' 9" | 9' 1" | 8' 1" |
| 2x6 #1 DF | 10' 11" | 9' 11" | 9' 4" | 8' 8" |
| 2x6 SS DF | 11' 4" | 10' 4" | 9' 8" | 9' 0" |
| <hr/> | | | | |
| 2x8 #2 DF | 14' 2" | 12' 7" | 11' 4" | 10' 3" |
| 2x8 #1 DF | 14' 5" | 13' 1" | 12' 4" | 11' 0" |
| 2x8 SS DF | 15' 0" | 13' 7" | 12' 10" | 11' 11" |
| <hr/> | | | | |
| 2x10 #2 DF | 17' 9" | 15' 5" | 14' 1" | 12' 7" |
| 2x10 #1 DF | 18' 5" | 16' 5" | 15' | 13' 5" |
| 2x10 SS DF | 19' 1" | 17' 4" | 16' 4" | 15' 2" |
| <hr/> | | | | |
| 2x12 #2 DF | 20' 7" | 17' 10" | 16' 3" | 14' 7" |
| 2x12 #1 DF | 22' 0" | 19' 1" | 17' 5" | 15' 7" |
| 2x12 SS DF | 23' 3" | 21' 1" | 19' 10" | 18' 5" |

CEILING JOISTS -- 20# LL - Uninhabitable attics with limited storage, 20 psf live load

| | <u>12" o.c.</u> | <u>16" o.c.</u> | <u>19.2" o.c.</u> | <u>24" o.c.</u> |
|------------|-----------------|-----------------|-------------------|-----------------|
| 2x4 #2 DF | 9' 10" | 8' 9" | 8' 0" | 7' 2" |
| 2x4 #1 DF | 10' 0" | 9' 1" | 8' 7" | 7' 8" |
| 2x4 SS DF | 10' 5" | 9' 6" | 8' 11" | 8' 3" |
| 2x6 #2 DF | 14' 10" | 12' 10" | 11' 9" | 10' 6" |
| 2x6 #1 DF | 15' 9" | 13' 9" | 12' 6" | 11' 2" |
| 2x6 SS DF | 16' 4" | 14' 11" | 14' 0" | 13' 0" |
| 2x8 #2 DF | 18' 9" | 16' 3" | 14' 10" | 13' 3" |
| 2x8 #1 DF | 20' 1" | 17' 5" | 15' 10" | 14' 2" |
| 2x8 SS DF | 21' 7" | 19' 7" | 18' 5" | 17' 1" |
| 2x10 #2 DF | 22' 11" | 19' 10" | 18' 2" | 16' 3" |
| 2x10 #1 DF | 24' 6" | 21' 3" | 19' 5" | 17' 4" |
| 2x10 SS DF | N/A | N/A | 23' 4" | 20' 11" |

RAFTERS -- Roof live load 20 psf ceiling not attached to rafters. Dead load 20 psf.

| | <u>12" o.c.</u> | <u>16" o.c.</u> | <u>19.2" o.c.</u> | <u>24" o.c.</u> |
|------------|-----------------|-----------------|-------------------|-----------------|
| 2x4 #2 DF | 9' 10" | 8' 6" | 7' 9" | 6' 11" |
| 2x4 #1 DF | 10' 6" | 9' 1" | 8' 4" | 7' 5" |
| 2x4 SS DF | 11' 6" | 10' 5" | 9' 10" | 8' 11" |
| 2x6 #2 DF | 14' 4" | 12' 5" | 11' 4" | 10' 2" |
| 2x6 #1 DF | 15' 4" | 13' 3" | 12' 2" | 10' 10" |
| 2x6 SS DF | 18' 0" | 16' 0" | 14' 7" | 13' 1" |
| 2x8 #2 DF | 18' 2" | 15' 9" | 14' 4" | 12' 10" |
| 2x8 #1 DF | 19' 5" | 16' 10" | 15' 4" | 13' 9" |
| 2x8 SS DF | 23' 5" | 20' 3" | 18' 6" | 16' 7" |
| 2x10 #2 DF | 22' 3" | 19' 3" | 17' 7" | 15' 8" |
| 2x10 #1 DF | 23' 9" | 20' 7" | 18' 9" | 16' 9" |
| 2x10 SS DF | N/A | N/A | 22' 7" | 20' 3" |

TABLE R602.3(1) FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

| ITEM | DESCRIPTION OF BUILDING ELEMENTS | NUMBER AND TYPE OF FASTENER ^{a, b, c} | SPACING OF FASTENERS |
|-------|---|--|--|
| Roof | | | |
| 1 | Blocking between joists or rafters to top plate, toe nail | 3-8d (2 ¹ / ₂ " × 0.113") | — |
| 2 | Ceiling joists to plate, toe nail | 3-8d (2 ¹ / ₂ " × 0.113") | — |
| 3 | Ceiling joists not attached to parallel rafter, laps over partitions, face nail | 3-10d | — |
| 4 | Collar tie rafter, face nail or 1 ¹ / ₄ " × 20 gage ridge strap | 3-10d (3" × 0.128") | — |
| 5 | Rafter to plate, toe nail | 2-16d (3 ¹ / ₂ " × 0.135") | — |
| 6 | Roof rafters to ridge, valley or hip rafters: | | |
| | toe nail | 4-16d (3 ¹ / ₂ " × 0.135") | — |
| | face nail | 3-16d (3 ¹ / ₂ " × 0.135") | — |
| Wall | | | |
| 7 | Built-up corner studs | 10d (3" × 0.128") | 24" o.c. |
| 8 | Built-up header, two pieces with ¹ / ₂ " spacer | 16d (3 ¹ / ₂ " × 0.135") | 16" o.c. along each edge |
| 9 | Continued header, two pieces | 16d (3 ¹ / ₂ " × 0.135") | 16" o.c. along each edge |
| 10 | Continuous header to stud, toe nail | 4-8d (2 ¹ / ₂ " × 0.113") | — |
| 11 | Double studs, face nail | 10d (3" × 0.128") | 24" o.c. |
| 12 | Double top plates, face nail | 10d (3" × 0.128") | 24" o.c. |
| 13 | Double top plates, minimum 24-inch offset of end joints, face nail in lapped area | 8-16d (3 ¹ / ₂ " × 0.135") | — |
| 14 | Sole plate to joist or blocking, face nail | 16d (3 ¹ / ₂ " × 0.135") | 16" o.c. |
| 15 | Sole plate to joist or blocking at braced wall panels | 3-16d (3 ¹ / ₂ " × 0.135") | 16" o.c. |
| 16 | Stud to sole plate, toe nail | 3-8d (2 ¹ / ₂ " × 0.113") | — |
| | | or 2-16d 3 ¹ / ₂ " × 0.135") | — |
| 17 | Top or sole plate to stud, end nail | 2-16d (3 ¹ / ₂ " × 0.135") | — |
| 18 | Top plates, laps at corners and intersections, face nail | 2-10d (3" × 0.128") | — |
| 19 | 1" brace to each stud and plate, face nail | 2-8d (2 ¹ / ₂ " × 0.113") 2 staples 1 ³ / ₄ " | — — |
| 20 | 1" × 6" sheathing to each bearing, face nail | 2-8d (2 ¹ / ₂ " × 0.113") | — |
| | | 2 staples 1 ³ / ₄ " | — |
| 21 | 1" × 8" sheathing to each bearing, face nail | 2-8d (2 ¹ / ₂ " × 0.113") | — |
| | | 3 staples 1 ³ / ₄ " | — |
| 22 | Wider than 1" × 8" sheathing to each bearing, face nail | 3-8d (2 ¹ / ₂ " × 0.113") | — |
| | | 4 staples 1 ³ / ₄ " | — |
| Floor | | | |
| 23 | Joist to sill or girder, toe nail | 3-8d (2 ¹ / ₂ " × 0.113") | — |
| 24 | 1" × 6" subfloor or less to each joist, face nail | 2-8d (2 ¹ / ₂ " × 0.113") | — |
| | | 2 staples 1 ³ / ₄ " | — |
| 25 | 2" subfloor to joist or girder, blind and face nail | 2-16d (3 ¹ / ₂ " × 0.135") | — |
| 26 | Rim joist to top plate, toe nail (roof applications also) | 8d (2 ¹ / ₂ " × 0.113") | 6" o.c. |
| 27 | 2" planks (plank & beam – floor & roof) | 2-16d (3 ¹ / ₂ " × 0.135") | at each bearing |
| 28 | Built-up girders and beams, 2-inch lumber layers | 10d (3" × 0.128") | Nail each layer as follows: 32" o.c. at top and bottom and staggered. Two nails at ends and at each splice. |
| 29 | Ledger strip supporting joists or rafters | 3-16d (3 ¹ / ₂ " × 0.135") | At each joist or rafter |

TABLE R602.3(1)—continued FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

| ITEM | DESCRIPTION OF BUILDING MATERIALS | DESCRIPTION OF FASTENER ^{b, c, e} | SPACING OF FASTENERS | |
|---|--|--|-----------------------------|--|
| | | | Edges (inches) ⁱ | Intermediate supports ^{c, e} (inches) |
| Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing | | | | |
| 30 | $\frac{3}{8}$ " - $\frac{1}{2}$ " | 6d common (2" × 0.113") nail (subfloor wall) ^l 8d common (2 $\frac{1}{2}$ " × 0.131") nail (roof) | 6 | 12 ^g |
| 31 | $\frac{5}{16}$ " - $\frac{1}{2}$ " | 6d common (2" × 0.113") nail (subfloor, wall) 8d common (2 $\frac{1}{2}$ " × 0.131") nail (roof) ^f | 6 | 12 ^g |
| 32 | $\frac{19}{32}$ " - 1" | 8d common nail (2 $\frac{1}{2}$ " × 0.131") | 6 | 12 ^g |
| 33 | 1 $\frac{1}{8}$ " - 1 $\frac{1}{4}$ " | 10d common (3" × 0.148") nail or 8d (2 $\frac{1}{2}$ " × 0.131") deformed nail | 6 | 12 |
| Other wall sheathing ^b | | | | |
| 34 | $\frac{1}{2}$ " structural cellulosic fiberboard sheathing | $\frac{1}{2}$ " galvanized roofing nail, $\frac{7}{16}$ " crown or 1" crown staple 16 ga., 1 $\frac{1}{4}$ " long | 3 | 6 |
| 35 | $\frac{25}{32}$ " structural cellulosic fiberboard sheathing | 1 $\frac{3}{4}$ " galvanized roofing nail, $\frac{7}{16}$ " crown or 1" crown staple 16 ga., 1 $\frac{1}{2}$ " long | 3 | 6 |
| 36 | $\frac{1}{2}$ " gypsum sheathing ^d | 1 $\frac{1}{2}$ " galvanized roofing nail; staple galvanized, 1 $\frac{1}{2}$ " long; 1 $\frac{1}{4}$ screws, Type W or S | 7 | 7 |
| 37 | $\frac{5}{8}$ " gypsum sheathing ^d | 1 $\frac{3}{4}$ " glvanized roofing nail; staple galvanized, 1 $\frac{5}{8}$ " long; 1 $\frac{5}{8}$ " screws, Type W or S | 7 | 7 |
| Wood structural panels, combination subfloor underlayment to framing | | | | |
| 38 | $\frac{3}{4}$ " and less | 6d deformed (2" × 0.120") nail or 8d common (2 $\frac{1}{2}$ " × 0.131") nail | 6 | 12 |
| 39 | $\frac{7}{8}$ " - 1" | 8d common (2 $\frac{1}{2}$ " × 0.131") nail or 8d deformed (2 $\frac{1}{2}$ " × 0.120") nail | 6 | 12 |
| 40 | 1 $\frac{1}{8}$ " - 1 $\frac{1}{4}$ " | 10d common (3" × 0.148") nail or 8d deformed (2 $\frac{1}{2}$ " × 0.120") nail | 6 | 12 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1ksi = 6.895 MPa.

a. All nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.

b. Staples are 16 gage wire and have a minimum ⅞-inch on diameter crown width.

c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.

d. Four-foot-by-8-foot or 4-foot-by-9-foot panels shall be applied vertically.

e. Spacing of fasteners not included in this table shall be based on Table R602.3(2).

f. For regions having basic wind speed of 110 mph or greater, 8d deformed (2½" × 0.120) nails shall be used for attaching plywood and wood structural panel roof sheathing to framing within minimum 48-inch distance from gable end walls, if mean roof height is more than 25 feet, up to 35 feet maximum.

g. For regions having basic wind speed of 100 mph or less, nails for attaching wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches on center. When basic wind speed is greater than 100 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches on center for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches on center to gable end wall framing.

h. Gypsum sheathing shall conform to ASTM C 1396 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to ASTM C 208.

i. Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at all floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.

DRYWALL

GENERAL

Drywall (sheetrock) is the interior finish most commonly used in residential construction. The following guidelines pertain to its application.

Gypsum wallboard shall not be installed until rough inspections are completed and exterior is weather protected.

When practical, wallboard should be applied first to the ceilings, and then to walls. Sheets should be brought into contact but not forced into place. Spaces between sheets should not exceed 1/4" and tapered edges should be placed next to each other when possible.

Cutouts for electrical outlets, pipes, fixtures or other small openings should be cut out neatly with a maximum clearance of 1/8". If there are any gaps exceeding 1/4", they must be filled with joint compound and drywall tape.

NAILING

Nails should be driven so that the head is in a small dimple formed by the last blow of the hammer. Take care not to fracture the board when nailing. Fractures of the wallboard caused by over driving must be corrected by additional nailing. Nails should be 3/8" from the edges, and nails on adjacent edges should be opposite each other. If you are using the nailing system, the nails should be spaced 7" on center on the ceilings and 8" on center on the walls. Approved screws may also be used to apply wallboard. Screws must be placed 3/8" from the end or edges of the board and spaced 12" on center. Screws must be used for fastening wallboard at pocket doors.

CORNERS

All reinforced corners must fit snugly against wallboard and should be nailed approximately 12" on center. All "L" edge metal trim should be nailed every 6". Paperback corner bead is acceptable if installed in accordance with the manufacturer's instructions.

DRYWALL IN SHOWER ENCLOSURES

Greenboard is not allowed where subject to direct water exposure (tubs or showers) or high humidity (saunas). Use cement, fiber-cement or glass mat gypsum backers as a base for wall tile in tub and shower areas.

DRYWALL IN FIRE RESISTIVE CONSTRUCTION

There are areas in residential construction where one-hour fire resistive construction is required. One area is the wall separating an attached garage from the living area, and another is enclosed useable space (walls and ceilings) under a stairway. A typical one-hour firewall is constructed as follows: 5/8" type "X" gypsum wallboard is nailed 7" on center to studs spaced 16" on center and at all edges. All gaps and penetrations must be taped or fire-caulked.

MINIMUM THICKNESS AND APPLICATION OF GYPSUM BOARD

| THICKNESS OF GYPSUM BOARD (inches) | APPLICATION N | ORIENTATION OF GYPSUM BOARD TO FRAMING | MAXIMUM SPACING OF FRAMING MEMBERS (inches o.c.) | MAXIMUM SPACING OF FASTENERS (inches) | | SIZE OF NAILS FOR APPLICATION TO WOOD FRAMING |
|---|----------------------|--|--|---------------------------------------|--------|---|
| | | | | Nails ^a | Screws | |
| Screws - Shall be long enough for the full-diameter portion to penetrate into wood framing not less than 5/8" and three times the thickness of the framing member; or 3d cooler nail, 1 1/4" long, annular-ringed; or 4d cooler nail, 0.080" diameter, 1 3/8" long, 7/32" head. | | | | | | |
| Application without adhesive | | | | | | |
| 3/8 | Ceiling ^d | Perpendicular | 16 | 7 | 16 | 13 gage, 1 3/8" long, 19/64" head; 0.098" diameter, 1 1/4" long, annular-ringed; 5d cooler nail, 0.086" diameter, 1 5/8" long, 15/64" head; or gypsum board nail, 0.086" diameter, 1 5/8" long, 9/32" head. |
| | Wall | Either direction | 16 | 8 | 16 | |
| 1/2 | Ceiling | Either direction | 16 | 7 | 12 | 13 gage, 1 3/8" long, 19/64" head; 0.098" diameter, 1 1/4" long, annular-ringed; 5d cooler nail, 0.086" diameter, 1 5/8" long, 15/64" head; or gypsum board nail, 0.086" diameter, 1 5/8" long, 9/32" head. |
| | Ceiling ^d | Perpendicular | 24 | 7 | 12 | |
| | Wall | Either direction | 24 | 8 | 12 | |
| | Wall | Either direction | 16 | 8 | 16 | |
| 5/8 | Ceiling | Either direction | 16 | 7 | 12 | 13 gage, 1 5/8" long, 19/64" head; 0.098" diameter, 1 3/8" long, annular-ringed; 6d cooler nail, 0.092" diameter, 1 7/8" long, 1/4" head; or gypsum board nail, 0.0915" diameter, 1 7/8" long, 19/64" head. |
| | Ceiling ^e | Perpendicular | 24 | 7 | 12 | |
| | Wall | Either direction | 24 | 8 | 12 | |
| | Wall | Either direction | 16 | 8 | 16 | |
| Application with adhesive | | | | | | |
| 3/8 | Ceiling ^d | Perpendicular | 16 | 16 | 16 | Same as above for 3/8" gypsum board |
| | Wall | Either direction | 16 | 16 | 24 | |
| 1/2 or 5/8 | Ceiling | Either direction | 16 | 16 | 16 | Same as above for 1/2" and 5/8" gypsum board, respectively |
| | Ceiling ^d | Perpendicular | 24 | 12 | 16 | |
| | Wall | Either direction | 24 | 16 | 24 | |
| Two 3/8 layers | Ceiling | Perpendicular | 16 | 16 | 16 | Base ply nailed as above for 1/2" gypsum board; face ply installed with adhesive |
| | Wall | Either direction | 24 | 24 | 24 | |

For SI: 1 inch = 25.4 mm.

- For application without adhesive, a pair of nails spaced not less than 2 inches apart or more than 2 1/2 inches apart may be used with the pair of nails spaced 12 inches on center.
- Screws shall be in accordance with Section R702.3.6. Screws for attaching gypsum board to structural insulated panels shall penetrate the wood structural panel facing not less than 7/16 inch.
- Where cold-formed steel framing is used with a clinching design to receive nails by two edges of metal, the nails shall be not less than 5/8 inch longer than the gypsum board thickness and shall have ringed shanks. Where the cold-formed steel framing has a nailing groove formed to receive the nails, the nails shall have barbed shanks or be 5d, 13 1/2 gage, 15/8 inches long, 15/64-inch head for 1/2-inch gypsum board; and 6d, 13 gage, 1 7/8 inches long, 15/64-inch head for 5/8-inch gypsum board.
- Three-eighths-inch-thick single-ply gypsum board shall not be used on a ceiling where a water-based textured finish is to be applied, or where it will be required to support insulation above a ceiling. On ceiling applications to receive a water-based texture material, either hand or spray applied, the gypsum board shall be applied perpendicular to framing. When applying a water-based texture material, the minimum gypsum board thickness shall be increased from 3/8 inch to 1/2 inch for 16-inch on center framing, and from 1/2 inch to 5/8 inch for 24-inch on center framing or 1/2-inch sag-resistant gypsum ceiling board shall be used.
- Type X gypsum board for garage ceilings beneath habitable rooms shall be installed perpendicular to the ceiling framing and shall be fastened at maximum 6 inches o.c. by minimum 1 7/8 inches 6d coated nails or equivalent drywall screws.

RECOMMENDED FASTENERS FOR DRYWALL

Fastener lengths for gypsum to wood framing

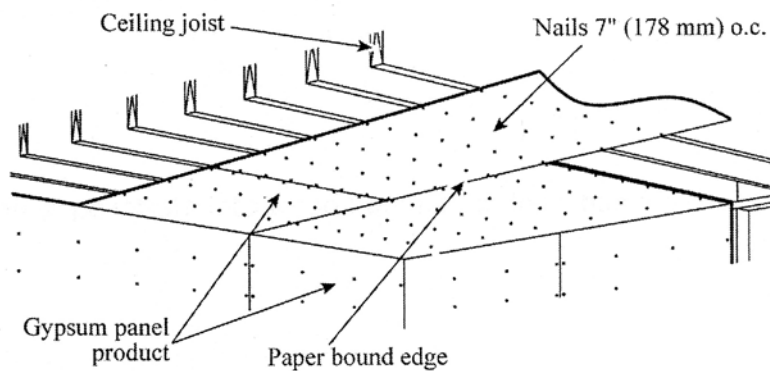
| Gypsum | Nails | Screws |
|--------|--------|--------|
| 1/2" | 1 3/8" | 1 1/8" |
| 5/8" | 1 1/2" | 1 1/4" |

Gypsum Board Fastener Spacing

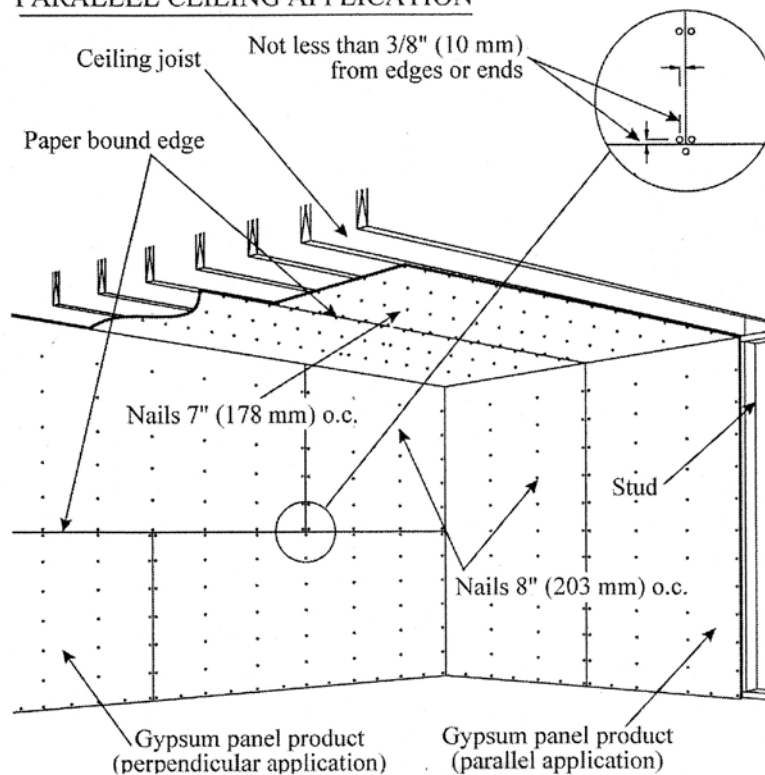
| | | |
|-----------|----------|------------|
| Ceiling - | Nails 7" | Screws 12" |
| Walls - | Nails 8" | Screws 12" |

Single nailing

PERPENDICULAR CEILING APPLICATION



PARALLEL CEILING APPLICATION



CALIFORNIA MECHANICAL CODE

GENERAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PROHIBITED LOCATIONS FOR FUEL BURNING APPLIANCES

In general, fuel-burning appliances can't be installed in bedrooms, bathrooms or closets, or any room or compartment, which opens directly into any of these. However, there are some exceptions.

Exceptions

- 1) This doesn't apply to direct vent appliances, which get combustion air from and vent directly to the outside, usually through a wall.
- 2) Vented appliances such as wall furnaces and gas fireplaces may be installed in these rooms if the rooms contain at least 50 cubic feet of volume for each 1000 Btu's of fuel input.
- 3) A fireplace may be installed in a bedroom or bathroom of any size if it has a listed method of getting its combustion air from outside the building.
- 4) A central furnace compartment may have access through a bedroom or bathroom if all combustion air is obtained from outside the building and the compartment is accessed through a tight-fitting gasketed door with a closer.

ELECTRICAL REQUIREMENTS

Each piece of mechanical equipment must have an electrical disconnect within sight and a 110V receptacle within 25' on the same level as the equipment. Lighting controlled by a switch at the access opening must also be provided for interior mechanical equipment, including attic and underfloor installations.

ACCESS AND WORKING SPACE

Rooms and compartments containing mechanical equipment must have a door at least 24" wide and big enough to remove the equipment. When the door is open, the front or service side of the equipment must have a clear working space of 30" wide, 30" deep, and 30" high or the height of the equipment, whichever is greater.

Attic equipment must be accessible by an opening at least 22" x 30" and big enough to remove the equipment. The passageway from the access opening to the equipment must be at least 30" wide and 30" high, and provided with continuous solid flooring at least 24" wide. A level working platform at least 30" square is required at the front or service side of the equipment. This platform may be omitted if the equipment can be serviced and removed from a ladder in the access opening.

Access and working space requirements for underfloor equipment are the same as attic equipment except that the passageway need not be provided with flooring.

SUPPORT OF EQUIPMENT

All mechanical equipment must be supported against vertical and horizontal movement in accordance with the engineering provisions of the Building Code. This is sometimes a problem with attic furnace installations, where the unit is not rigidly attached to the structure. Lateral bracing must be provided, typically straps running at a 45° angle from each corner of the unit to rigid framing members and tight enough to prevent horizontal movement. Concerns about vibration must be addressed with isolation devices, not by omitting required supports. The rafters or trusses must also be designed to handle the additional weight of the equipment.

"Piping, electrical conduit, ductwork, vents and the like shall not be used to provide support or restraint of equipment."

ELEVATION OF IGNITION SOURCE

Equipment that has a flame generates a spark or uses a glowing ignition source open to a garage in which it is installed must be elevated at least 18 inches above the floor. Equipment enclosed in a separate compartment having access only from outside of the garage may be installed at floor level, providing the required combustion air is not taken from the garage. **Water heaters listed as flammable vapor ignition resistant can be installed at floor level.**

CRASH BARRIERS

Equipment regulated by the Mechanical Code must be protected when placed in the drive path directly in line with a vehicle or if outdoors and subject to vehicular impact. This is usually done with one or more 4" trade size steel pipe bollards, embedded at least 24" into concrete, and 36" above grade.

HEATING AND COOLING SYSTEMS

COMBUSTION AIR

Permanent openings must be provided to supply combustion air to most fuel-burning appliances. Exceptions are direct-vent appliances, listed cooking appliances, and domestic clothes dryers.

An adequate supply of combustion air can be obtained from infiltration into a building of ordinary tightness if the volume of the room containing the appliance has at least 50 cubic feet of volume for each 1000 BTU's of fuel input. Hallways or other rooms, which are permanently open to the room containing the appliance, may be included in the volume calculation. Doors are not permanent openings.

If the volume of the room is not sufficient, all or part of the combustion air must be provided from another source. This includes permanent openings to another part of the building that has adequate volume, and openings or ducts directly to the outside or to accessible attics or underfloor spaces if they are adequately vented to the outside. If outside air must be used, the room or space containing the appliance becomes unconditioned space and must be separated from conditioned space in the building with insulated walls, weather-stripped doors, etc. This can be done by installing the appliance in a small compartment.

Outside combustion air can be provided by openings directly through walls, floors or ceilings, or by ducts. Two openings or ducts are generally required, one within 12" of the ceiling and one within 12" of the floor. If all combustion air is taken from outside the building, it may be provided through a single opening or duct within 12" of the ceiling.

If a duct is used to supply combustion air to the top of the enclosure, it must extend horizontally or upwards to the source of air. A duct supplying air to the bottom of the enclosure can run in any direction. Upper and lower ducts must be completely separate to the source of combustion air.

If permanent openings are used to obtain combustion air from another part of the building, they must each have 1 square inch for each 1000 BTU's of fuel input or 100 square inches, whichever is more.

If combustion air is being taken from outside or from the attic or underfloor space, each opening or vertical duct must have at least 1 square inch for each 4000 BTU's of fuel input. Horizontal ducts must have at least 1 square inch for each 2000 BTU's of fuel input. If a single upper opening or duct is being used, it must have at least 1 square inch for each 3000 BTU's of fuel input.

VENTS AND CHIMNEYS

Unvented fuel-burning appliances used for space heating are prohibited in residences.

Single wall pipe may be used only as a connector between an appliance and its vent or chimney and only in an exposed location. It can't be used in an attic, or in any concealed space. When used with residential gas appliances, it must be kept at least 6" from combustible materials and for woodstoves at least 18". All joints in single wall connectors must be fastened with sheetmetal screws or rivets, including the connection to the chimney or vent.

Concealed portions of vents and chimneys, other than masonry or concrete chimneys, must be constructed with listed pipe and fittings and must maintain the listed clearance from combustibles. In the case of gas appliances, listed pipe and fittings will be double-wall, or B-vent and generally require 1" clearance from combustibles. For woodstoves, a variety of listed chimney systems are available. These generally require 2" clearance from combustibles. Requirements for the installation of all these factory-made systems are found in the manufacturer's installation instructions, not in the codebooks.

Pitch is important in gravity venting systems, since the tendency of heat to rise makes them work. If too much of the pipe is too flat, the system will stall. Connectors may be as flat as 1/4" rise per foot, but must be as short as possible. Beyond the connector, no part of a gas vent can be flatter than 60° from vertical. But the total horizontal run of connector and vent must not exceed 75% of the total vertical rise. Stated another way, the vent system must be more vertical than horizontal. This is sometimes a problem when people want all the vents toward the back of the roof where they can't be seen from the street. If an appliance is too far toward the front of the house, this may not be possible.

Gravity-type venting systems, other than a Type BW system or a venting system, which is an integral part of a listed appliance, must extend at least 5 feet above the appliance vent collar. A Type BW vent serving a wall furnace must extend at least 12' above the bottom of the furnace.

Since gas vents must terminate at least 8' from any wall or other vertical surface, they are normally extended above the (highest) roof, clear of all walls. The termination must be at least 3' above or 10' horizontally from any forced air intake.

CONDENSATE

Condensing appliances must be vented in accordance with the manufacturer's installation instructions. Liquid condensate from condensing appliances and cooling coils must be piped to an approved plumbing fixture or disposal area. Such piping must be no smaller than the drain pan connection on the approved appliance, must be corrosion resistant (normally PVC) and sloped at least 1/8" per foot. When condensate is generated above usable space, a separate overflow drain must be provided, sloped at least 1/8" per foot, and discharging at a "readily observable" location. An example of such a location is directly above a door or window. The purpose of locating the outlet in this manner is to alert the building occupant that something is wrong if the primary drain becomes clogged.

HEATING DUCT SYSTEMS

Ducts must be installed at least 4" above earth. This applies to metal ducts and flexible ducts. Supports must be at least 1 1/2" wide and be placed at intervals recommended by the manufacturer, but no more than 4' apart. Ducts in an underfloor area must not obstruct access to any part of the crawl space.

Risers must be constructed of metal in duct systems serving more than two stories.

WALL FURNACES

When wall furnaces are installed in existing buildings, the wall on one side of the vent must be completely opened for installation and inspection. The wall cavity containing the vent must be free of obstructions, and the plates at the top of the cavity must be cut flush with the studs.

The top of the wall in the story containing the furnace must have ceiling plate spacers, which allow ventilation into the attic or wall cavity above. The top of any walls above the story containing the furnace must have fire stop spacers, which close the opening around the pipe. Both types of spacers must be listed parts of the venting system.

If the story containing the furnace has an attic above with sufficient height, a sheetmetal sleeve the size of the wall cavity must extend from the top of the wall cavity to a point above the attic insulation. But it must keep back from the roof sheathing at least 2" to allow adequate air circulation.

If the story containing the furnace has an attic above without sufficient height to provide adequate ventilation of the wall cavity, a ventilated roof flashing or a ventilation opening in the wall directly above the furnace and no more than 12" from the ceiling may provide ventilation.

VENT TERMINATION ABOVE ROOF

| ROOF SLOPES | FEET-INCHES |
|---------------------|-------------|
| Flat to 6/12 | 1-0 |
| Over 6/12 to 7/12 | 1-3 |
| Over 7/12 to 8/12 | 1-6 |
| Over 8/12 to 9/12 | 2-0 |
| Over 9/12 to 10/12 | 2-6 |
| Over 10/12 to 11/12 | 3-3 |
| Over 11/12 to 12/12 | 4-0 |

WOOD-BURNING STOVES AND FIREPLACES

Woodstove chimneys must terminate in accordance with the manufacturer's installation instructions, generally 3' above the point of penetration and 2' above any part of the building within 10'. Wood stoves and factory-built wood-burning fireplaces must be installed according to the manufacturer's installation instructions. Wood stoves usually have a specification plate attached to the back that gives the required clearances from combustibles and floor protection. If no plate is present and no installation instructions are available, the stove cannot be installed in the City of San Bruno.

Bay Area Air Quality Management has set regulations for any permanently installed wood-burning device installed indoors in new construction or remodel be any of the following:

- A U.S. EPA Phase II certified wood burning device
- A pellet fueled device
- Listed on the Air District's list of approved devices.

Conventional Fireplaces are no longer permitted. Gas fueled or electric powered fireplace devices are allowed. A list of approved wood burning devices can be found at: www.baaqmd.gov/pio/wood_burning/index.htm.

EXHAUST SYSTEMS

Exhaust ducts for bathroom fans, range hoods, and clothes dryers must terminate outside of the building at least 3' from an openable window, door or property line. A backdraft damper must be provided.

Range hood exhaust ducts must be of metal and have smooth interior surfaces, flexible type ducting is not allowed.

Clothes dryer ducts must be of metal and have smooth interior surfaces, except that a maximum 6' length of flexible connector may be used within the room or space containing the dryer. Unless the manufacturer's installation instructions say otherwise, 14' of duct with two 90° elbows is the maximum length allowed. Two feet of length must be deducted for each elbow in excess of two. Joints in dryer ducts must not be connected with sheetmetal screws or other fasteners, which will obstruct the flow.

When a compartment or space is provided for a dryer, an exhaust duct must be provided. If the dryer is located in a confined space, a permanent opening of at least 100 square inches must be provided for makeup air.

CALIFORNIA PLUMBING CODE

DRAINAGE AND VENTING SYSTEMS

MINIMUM SIZE OF TRAPS AND DRAINAGE PIPES

| Fixture | Min. Trap Size | Min. Horizontal Pipe Size | Min. Vertical Pipe Size |
|----------------|-------------------|---------------------------|-------------------------|
| Bathtub | 1 1/2" | 2" | 1 1/2" |
| Clothes washer | 2" | 2" | 1 1/2" |
| Laundry Sink | 1 1/2" | 2" | 1 1/2" |
| Shower | 2" | 2" | 2" |
| Kitchen Sink | 1 1/2" | 2" | 2" |
| Bar Sink | 1 1/2" | 1 1/2" | 1 1/2" |
| Wash Basin | 1 1/4" | 1 1/4" | 1 1/4" |
| Toilet | built into toilet | 3" | 3" |

CHANGE-OF-DIRECTION FITTINGS

Changes of direction in drainage piping must be made with 1/16 bends (22 1/2°), 1/8 bends (45°), 1/6 bends (60°), or other fittings with equivalent sweep. Quarter bends (90°) do not have equivalent sweep unless they are the long sweep type.

Where one drainage pipe discharges into another, it must be through a wye (45° or 60°), or combination wye and 1/8 bend (also called combo or long turn tee-wye) except in the case of a horizontal pipe discharging into a vertical pipe. In this case, a sanitary tee is acceptable. A horizontal pipe is defined as sloping 45° or less from the horizontal. A vertical pipe is defined as sloping 45° or more from the horizontal.

CLEANOUTS

A cleanout is required at the upper end of every drainage pipe with the following exceptions:

- 1) Horizontal branches less than 5' long, unless they serve sinks or urinals.
- 2) Pipes, which slope 18° or more from the horizontal.
- 3) Pipes above the first story.

A cleanout is required every 100' and for each aggregate change of direction exceeding 135 degrees. Cleanouts must be accessible. Underfloor cleanouts must be within 20' of an access opening and there must be a clear passageway at least 18" high and 30" wide between the access opening and the cleanout. This means that any ducts or pipes, which cross this passageway, must have 18" clear space under them, which may require some digging. Twelve inches clear space is required in front of a cleanout 2" or smaller and 18" for those larger than 2". Cleanouts for underground pipes must be extended to grade.

SLOPE AND SUPPORT OF DRAINAGE PIPES

Drainage pipes must slope a minimum of 1/4" per foot, in cases where this is not possible, 4" pipe or larger can be sloped 1/8" to the foot. Horizontal ABS pipe must be supported at least every 4'.

TRAPS AND VENTING - GENERAL

Every plumbing fixture must have a trap and every trap must be protected with a vent pipe. The purpose of the trap is to form a water seal that prevents sewer gas from entering the building. The purpose of the vent is to assure that the water in the trap is not pushed or sucked out by the movement of water through other parts of the drainage system.

Each fixture must be separately vented before the drain from that fixture connects with the drain from any other fixture.

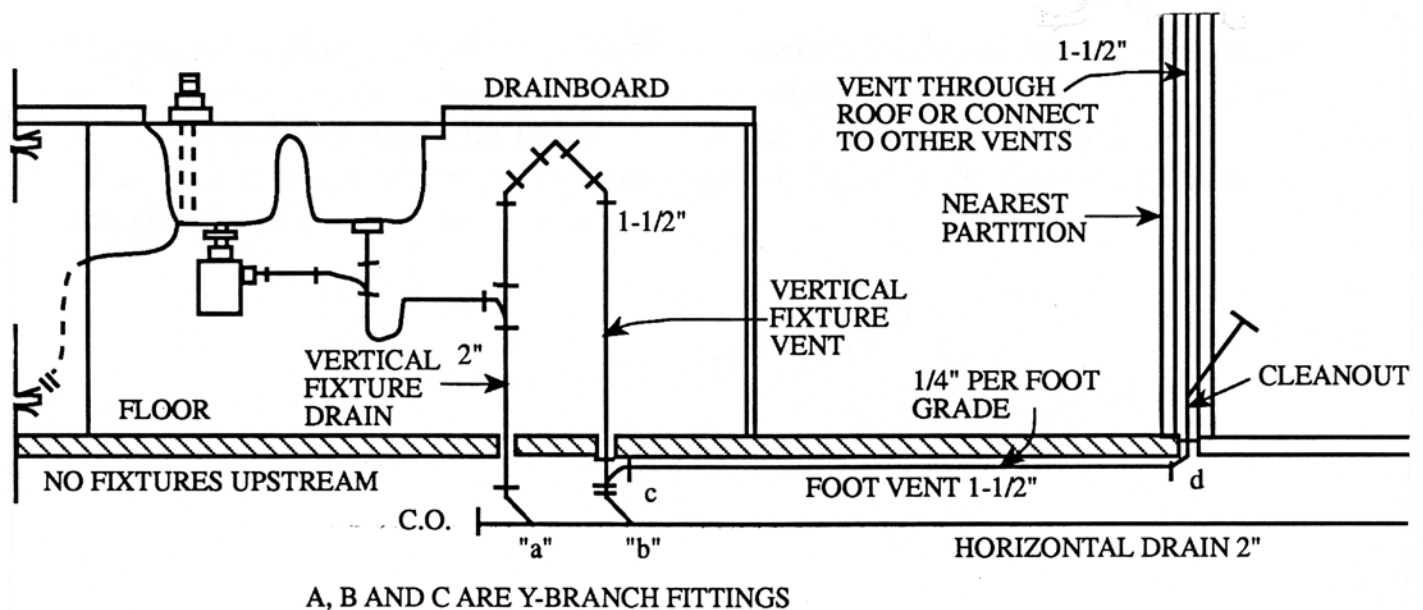
SPECIAL VENTING FOR ISLAND FIXTURES

Traps for island sinks and similar equipment shall be roughed in above the floor and may be vented by extending the vent as high as possible, but not less than the drainboard eight. The vent is then returned downward and connected to the horizontal sink drain immediately downstream from the vertical fixture drain.

The returned vent shall be connected to the horizontal drain through a wye-branch fitting and shall in addition be provided with a foot vent taken off the vertical fixture vent by means of a wye-branch fitting immediately below the floor. This foot vent extends to the nearest partition and thence through the roof to the open air, or may be connected to other vents at a point not less than six (6) inches above the flood level rim of the fixture served.

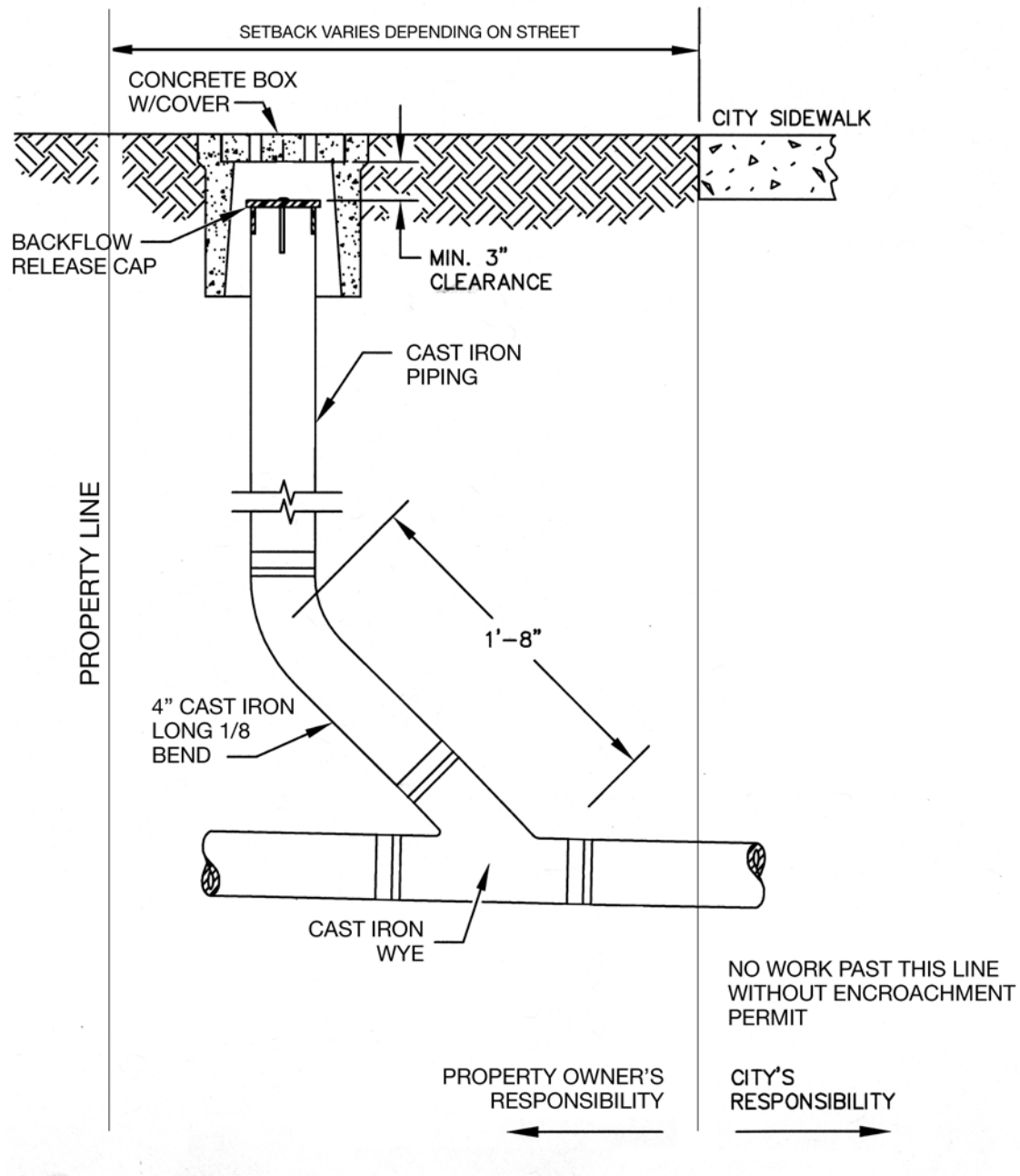
Drainage fittings shall be used on all parts of the vent below the floor line. This includes fittings noted as a, b, c, and d. The foot vent shall maintain a minimum slope of one-quarter (1/4) inch per foot back to the drain. The return bend used under the drainboard shall be a one piece fitting, or an assembly of a 45 degree, a 90 degree, and a 45 degree elbow in the order named. Pipe sizing shall be as required in the Code.

Special venting for island fixtures is a method for venting a fixture in an isolated location where vent pipes installed as normally required in UPC would not be practical.



SEWERS

SETBACK AREA _____



VENT PIPE SLOPE AND CONNECTIONS

Vent pipes must be graded and fittings arranged so that moisture will return to the drainage piping.

Where a vent pipe connects to a horizontal drainage pipe, it must connect to the upper half of the pipe. A vent connected to the side of a horizontal drainage pipe is not permitted. Vent pipes should not run horizontally (less than 45° slope) unless they are at least 6" above the flood level rim of the fixture they serve.

Except for toilets, the connection of the vent pipe to the drainage pipe must be above the level of the standing water in the trap.

SIZE OF VENT PIPES

| Fixture | Min. Vent Size |
|----------------|-----------------------|
| Bathtub | 1 1/2" |
| Clothes washer | 1 1/2" |
| Laundry Sink | 1 1/2" |
| Shower | 1 1/2" |
| Kitchen Sink | 1 1/2" |
| Bar Sink | 1 1/4" |
| Wash Basin | 1 1/4" |
| Toilet | 2" |

VENT TERMINATIONS

Vent pipes must terminate at least 6" above the roof and 1' from any vertical surface. The termination must also be 3' above or 10' horizontally from any openable skylight or window.

TESTING DWV SYSTEMS

Drainage and venting systems must be tested with air or water. A water test is done by closing all openings in the system and filling it with water to a height of at least 10' above the highest fitting. For the top-out test, tub waste-and-overflows and shower traps must be hooked up and included in the test. An air test of 5 psi is also acceptable, but must be done with a gauge, which reads maximum 10 psi at full scale.

SEWERS

The building sewer begins 2' outside the building and connects the building drainage system to the public sewer. Grading requirements are the same as for drainage pipes. A separate sewer cleanout is required and must be extended to grade. The sewer line is tested by plugging its lower end and filling it with water to its highest point. An air test of 5 psi is also acceptable. An inspection of the materials used, the installation and test of the building sewer must be approved before covering any work. Be sure you know what the required set back is for the sewer clean out location before starting installation. A pop-up cap (back pressure relief cap) is required at the property line cleanout.

WATER SUPPLY SYSTEMS

GENERAL REQUIREMENTS

Solder in potable water systems must be the “lead-free” type.

Underground water pipes must be at least 12” deep. Under slab copper pipe should be installed without joints where possible by using soft copper, which is available in 60’ and 100’ rolls. Where joints are necessary, they must be brazed rather than soldered and the fittings must be copper rather than brass. Copper and steel material should never be directly connected, they must be separated by brass or a dielectric fitting.

BACKFLOW PREVENTION DEVICES

Every hose outlet and every landscape watering device that connects to the potable water system must do so through a suitable backflow prevention device. Screw-on vacuum breakers are available for hose bibbs. Landscape watering devices can be supplied through a vacuum breaker provided the vacuum breaker is at least 6” above any outlet it serves, and further provided there are no shutoffs downstream from the vacuum breaker.

If there are any shutoffs downstream from the backflow prevention device, it must be a pressure vacuum breaker. These are required to be at least 12” above any outlet they serve.

Where the backflow prevention device is below any of the outlets it serves, a double check valve is required.

VALVES REQUIRED

Every building with water must have a full-bore valve (one with an opening as big as the pipe it serves) that shuts off the entire building. Water heaters are also required to have a full-bore valve on the cold water inlet. Shutoffs must be provided at each connection of a fixture or appliance to the water supply system.

PRESSURE REGULATORS

Water pressure at the point of use must be no less than 15 psi and no more than 80 psi. If the pressure exceeds 80 psi, a pressure regulator is required.

RELIEF VALVE

Storage water heaters must have a temperature and pressure relief valve with a drain to the outside of the building when practical. The end of this drain must be pointing down, unthreaded, and between 6” and 24” above the ground. Termination of this drain in the under-floor crawlspace is not acceptable.

SIZE OF WATER PIPES

The water supply pipe to any building must be at least 3/4”. Most homes will require a 1” supply pipe or larger, based on the number and type of outlets, the length of pipe from the source to the farthest outlet, and the pressure at the source.

SUPPORT OF WATER PIPES

Horizontal copper water pipes up to 1 1/2” size must be supported at least every 6 feet. A metal support must not touch a copper pipe directly. Any metal support in direct contact with a copper water pipe is a potential source of noise when the water is turned on and off at the fixtures.

Horizontal galvanized water pipes of 3/4" size or smaller must be supported at least every 10'. For 1" size and larger the supports must be at least every 12'. Please note this does not apply to gas pipe, which requires more support than water pipe.

Pipes, which are buried, must be continuously supported before backfilling. In rocky soil where an even trench bottom is not possible, use sand to provide an even bed for the pipe.

TESTING WATER SYSTEMS

Water piping must be tested with actual on-site water pressure or with 50-psi air pressure. These tests must hold tight for 15 minutes.

FUEL GAS SYSTEMS

GENERAL REQUIREMENTS

Above the ground gas piping can be black steel, galvanized steel, or CSST. Copper is not acceptable. Gas pipe must be at least 6" above the ground unless it's a type approved for burial. Buried gas pipe is not permitted within any building or structure.

Every appliance is required to have an accessible shutoff valve within 3' of the appliance and ahead of the union connection to the appliance.

CONNECTIONS

Where gas piping is to be concealed, connections shall be of the following type: pipe fittings such as elbows, tees and couplings. Where necessary to insert fittings in gas pipe that has been installed in a concealed location, the pipe shall be reconnected by the use of a ground joint union with the nut center-punched to prevent loosening by vibration.

UNDERGROUND GAS PIPE

Underground gas pipe must be factory coated steel pipe, or approved plastic gas pipe.

Factory coated steel pipe is required to be at least 12" below grade. All fittings, short nipples, and nicks in the factory coating must be wrapped with tape that is listed and marked for that purpose. Such tape is commonly available in 10 mil and 20-mil thickness, but it must be applied spirally so that the final thickness is at least 40 mils.

FLEXIBLE CONNECTORS

Appliance connections must be at least as big as the inlet of the appliance they serve. Flexible connectors must be totally exposed and can't penetrate any wall, floor or appliance housing. If used outside, they must have a label showing that they have been tested and approved for such use. The appliance shutoff valve must be immediately ahead of the flexible connector and at least as big as the connector.

SIZE OF GAS PIPES

Every section of gas pipe must be large enough to handle the maximum demand of all appliances that it serves. The 2010 Residential Code provides several different methods for calculating minimum pipe sizes for gas lines.

SUPPORT OF GAS PIPES

The following chart shows the maximum allowable interval between supports for gas pipe:

| Pipe Size | Horizontal Pipe | Vertical Pipe |
|------------------|-----------------|-------------------|
| 1/2" | 6' | 6' |
| 3/4" or 1" | 8' | 8' |
| 1 1/4" or larger | 10' | every floor level |

TESTING GAS SYSTEMS

Gas pipe must be tested with air pressure to insure that there are no leaks. Usually this test is performed at rough plumbing inspection. A test pressure of 10 psi is adequate, using a gauge that reads maximum 20 psi at full scale. The pipes must hold **all** of the pressure for a minimum of 15 minutes. If the volume of the piping system is large, more pressure or a longer test may be necessary. Final test is done after sheetrock, siding, etc. are completely installed, but before any valves or flexible connectors are added to the gas system. In the case of altering or adding to an existing gas system, the test must include the existing part of the system as well as the new work. This will involve removing all of the valves and capping the pipe at each outlet.

NEW GAS SERVICE

Before approval is given for PG&E to provide gas service, the gas test described above must be passed.

CALIFORNIA ELECTRICAL CODE

GENERAL ELECTRICAL REQUIREMENTS

EXCEPTIONS TO THE RULES

There are exceptions to most rules in the California Electrical Code, sometimes even exceptions to the exceptions. Most of these exceptions apply to unusual circumstances that seldom occur in residential construction. For the sake of keeping it simple, we have chosen not to list all of the exceptions to the general rules covered in this guide.

COLOR OF CONDUCTORS

Neutral (grounded) conductors must have white or light gray insulation. If they are #6 AWG or larger, they need not have continuous white or light gray insulation, but can be marked at the ends with white tape. These colors are reserved for neutral conductors and must not be used for any other type of conductor.

Equipment grounding conductors must be bare or have green insulation. If they are #6 AWG or larger, they need not have continuous green insulation, but can be marked at the ends with green tape. This color is reserved for equipment grounding conductors and must not be used for any other type of conductor.

SIZE OF CONDUCTORS

The minimum size of conductors is shown in Table 310-16 from the CEC. The more current a conductor carries, the higher its temperature gets. The maximum allowable current load for each conductor is determined by the temperature rating of its insulation (shown in the column headings of the table). Copper conductors can carry more current than aluminum conductors of the same size (copper is on the left side of the table, aluminum is on the right).

TABLE 310.16

Allowable Ampacities of Insulated Conductors Rated 0 Through 2000 Volts, 60°C Through 90°C (140°F Through °F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

| Size AWG or kcmil | Temperature Rating of Conductor (See Table 310.13.) | | | | | | Size AWG or kcmil |
|-------------------------|---|--|---|----------------------------------|--|---|----------------------|
| | 60°C (140°F) | 75°C (167°F) | 90°C (194°F) | 60°C (140°F) | 75°C (167°F) | 90°C (194°F) | |
| | | Types RHW, THHW, THW, THWN, XHHW, USE, ZW | Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2 | | Types RHW, THHW, THW, THWN, XHHW, USE | Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2 | |
| | Types TW, UF | | | Types TW, UF | | | |
| | COPPER | | | ALUMINUM OR COPPER-CLAD ALUMINUM | | | |
| 18 | -- | -- | 14 | -- | -- | -- | -- |
| 16 | -- | -- | 18 | -- | -- | -- | -- |
| 14* | 20 | 20 | 25 | -- | -- | -- | -- |
| 12* | 25 | 25 | 30 | 20 | 20 | 25 | 12* |
| 10* | 30 | 35 | 40 | 25 | 30 | 35 | 10* |
| 8 | 40 | 50 | 55 | 30 | 40 | 45 | 8 |
| 6 | 55 | 65 | 75 | 40 | 50 | 60 | 6 |
| 4 | 70 | 85 | 95 | 55 | 65 | 75 | 4 |
| 3 | 85 | 100 | 110 | 65 | 75 | 85 | 3 |
| 2 | 95 | 115 | 130 | 75 | 90 | 100 | 2 |
| 1 | 110 | 130 | 150 | 85 | 100 | 115 | 1 |
| 1/0 | 125 | 150 | 170 | 100 | 120 | 135 | 1/0 |
| 2/0 | 145 | 175 | 195 | 115 | 135 | 150 | 2/0 |
| 3/0 | 165 | 200 | 225 | 130 | 155 | 175 | 3/0 |
| 4/0 | 195 | 230 | 260 | 150 | 180 | 205 | 4/0 |
| 250 | 215 | 255 | 290 | 170 | 205 | 230 | 250 |
| 300 | 240 | 285 | 320 | 190 | 230 | 255 | 300 |
| 350 | 260 | 310 | 350 | 210 | 250 | 280 | 350 |
| 400 | 280 | 335 | 380 | 225 | 270 | 305 | 400 |
| 500 | 320 | 380 | 430 | 260 | 310 | 350 | 500 |
| 600 | 355 | 420 | 475 | 285 | 340 | 385 | 600 |
| 700 | 385 | 460 | 520 | 310 | 375 | 420 | 700 |
| 750 | 400 | 475 | 535 | 320 | 385 | 435 | 750 |
| 800 | 410 | 490 | 555 | 330 | 395 | 450 | 800 |
| 900 | 435 | 520 | 585 | 355 | 425 | 480 | 900 |
| 1000 | 455 | 545 | 615 | 375 | 445 | 500 | 1000 |
| 1250 | 495 | 590 | 665 | 405 | 485 | 545 | 1250 |
| 1500 | 520 | 625 | 705 | 435 | 520 | 585 | 1500 |
| 1750 | 545 | 650 | 735 | 455 | 545 | 615 | 1750 |
| 2000 | 560 | 665 | 750 | 470 | 560 | 630 | 2000 |

CORRECTION FACTORS

| Ambient Temp. (°C) | For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below. | | | | | | Ambient Temp. (°F) |
|-----------------------|---|------|------|------|------|------|-----------------------|
| 21-25 | 1.08 | 1.05 | 1.04 | 1.08 | 1.05 | 1.04 | 70-77 |
| 26-30 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 78-86 |
| 31-35 | 0.91 | 0.94 | 0.96 | 0.91 | 0.94 | 0.96 | 87-95 |
| 36-40 | 0.82 | 0.88 | 0.91 | 0.82 | 0.88 | 0.91 | 96-104 |
| 41-45 | 0.71 | 0.82 | 0.87 | 0.71 | 0.82 | 0.87 | 105-113 |
| 46-50 | 0.58 | 0.75 | 0.82 | 0.58 | 0.75 | 0.82 | 114-122 |
| 51-55 | 0.41 | 0.67 | 0.76 | 0.41 | 0.67 | 0.76 | 123-131 |
| 56-60 | -- | 0.58 | 0.71 | -- | 0.58 | 0.71 | 132-140 |
| 61-70 | -- | 0.33 | 0.58 | -- | 0.33 | 0.58 | 141-158 |
| 71-80 | -- | -- | 0.41 | -- | -- | 0.41 | 159-176 |

***Small Conductors.** Unless specifically permitted in 240.4(E) or 240.4(G), the overcurrent protection shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper; or 15 amperes for 12 AWG and 25 amperes for 10 AWG aluminum and copper-clad aluminum after any correction factors for ambient temperature and number of conductors have been applied.

ELECTRICAL CONNECTIONS

Connections of electrical conductors must be made with listed pressure devices such as wire nuts, split bolts, crimp connectors, clamping terminals, etc. This includes connections between grounding conductors. Simply twisting conductors together is not adequate. Soldering is only permitted after a connection with a listed pressure connector has already been made.

Aluminum conductors can only be connected using devices specifically listed for aluminum. The listing for these devices normally includes the use of anti-oxidation inhibitor on the conductors. This compound prevents the aluminum from oxidizing and becoming loose in the terminal or connector, which can cause arcing and fire.

All connections of conductors must be made in a listed enclosure or box. Splicing wires outside of enclosure and just taping them is never allowed.

WET LOCATIONS

Switches or circuit breakers in a wet location or outside of a building shall be enclosed in a weatherproof box or cabinet. Outdoor fixtures and equipment shall be listed for outdoor use. Outdoor receptacles shall be of the gasket-cover type for use in wet locations.

PROTECTION OF ELECTRICAL WIRING

Vegetation such as trees shall not be used for support of overhead conductor spans. See also GENERAL ROUGH WIRING REQUIREMENTS.

| Common Residential Service Requirements | | | | | |
|---|---|-----------|-----------|---|--|
| Service Size (Amps) | Conduit Size (Rigid Steel or IMC) | Wire Size | | Grounding Electrode & Water Bond Size (Copper) | Maximum Riser Height above Roof <i>without</i> bracing |
| | | Copper | Aluminum | | |
| 100 | 1¼" | #4 | #2 | #8 | 42" |
| 125 | 1½" | #2 | #1/0 | #6 | 42" |
| 200 | 2" | #2/0 | #4/0 | #4 | 54" |
| 400 | 3" | 400 kcmil | 600 kcmil | #1/0 | 78" |

ELECTRICAL DESIGN REQUIREMENTS

CIRCUITS

The minimum number of circuits for lights and general purpose receptacles in a residence is based on 3 watts per square foot. The total number of watts is then divided by 120V to give the required number of amps. The total amperage of lighting and general purpose receptacle circuits, as determined by their circuit breaker ratings, must equal or exceed this number. The required kitchen, bathroom, and laundry circuits described below can't be counted toward this minimum.

At least two 20A circuits must be provided for counter and other receptacles in the kitchen and other food-handling areas. These circuits can't serve any loads other than receptacles.

A dedicated 20A circuit must supply bathroom receptacles. One circuit can supply any number of bathrooms, but no other outlets are allowed on it.

The laundry must also have a dedicated 20A circuit.

Clothes dryers normally have a 30A circuit and ranges usually have a 40A or 50A circuit, depending on the particular appliance to be installed.

ARC-FAULT CIRCUIT-INTERRUPTER PROTECTION

In dwelling units, all 120-volt single phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit:

- ♦ family rooms
- ♦ dining rooms
- ♦ living rooms
- ♦ parlors
- ♦ libraries
- ♦ dens
- ♦ bedrooms
- ♦ sunrooms
- ♦ recreation rooms
- ♦ closets
- ♦ hallways,

or similar rooms or areas shall be protected by a listed **arc-fault circuit interrupter, combination-type**, installed to provide protection of the branch circuit.

RECEPTACLES

There is no specific limit to the number of receptacles that can be put on a residential branch circuit, but the CEC requires load be evenly proportioned among the circuits provided.

Receptacles must be installed in all habitable rooms so that an appliance with a 6' cord can be placed anywhere along the wall and be able to reach a receptacle without crossing a doorway, fireplace or similar opening and without using an extension cord. Stated another way, each wall space must have receptacles no more than 6' from each end and no more than 12' apart between end receptacles. A wall space may include any number of inside or outside corners, but ends at any door, fireplace, or other break in the wall across which a cord shouldn't be strung. Fixed room dividers are considered wall space, as are the fixed panels in multi-panel doors. Movable door panels mark the end of a wall space. Any wall space 2' or more in width needs at least one receptacle.

Countertops in food-handling areas must be provided with receptacles in accordance with the following rules:

- ◆ Any section of counter against a wall and 12" or more in width must have a receptacle within 24" of any point along the wall at the back of the counter. Counter sections separated by sinks or cooking appliances are considered separate sections.
- ◆ Island counters must have at least one receptacle.
- ◆ Any peninsula with two square feet or more of counter area, measured from the connecting edge, must have at least one receptacle.
- ◆ Receptacles must not be more than 18" above the countertop or in the case of islands or peninsulas, not more than 12" below it. Where receptacles are below the countertop, the countertop must not extend more than 6" beyond the base cabinet.

At least one receptacle must be installed in each of the following locations:

- ◆ In bathrooms within 36" of each basin location
- ◆ Outdoors in the front and back of the building
- ◆ At the clothes washer
- ◆ In basements
- ◆ In attached garages or detached garages with electricity
- ◆ In hallways 10' or more in length
- ◆ Within 25' of mechanical equipment and on the same level. This is a mechanical code requirement.

All receptacles in the following locations must be ground-fault circuit-interrupter receptacles, usually referred to as GFI receptacles:

- ◆ Bathrooms
- ◆ Garages
- ◆ Grade-level accessory buildings used for storage or work areas
- ◆ Outdoors
- ◆ Underfloor crawlspaces
- ◆ Basements other than habitable rooms
- ◆ Kitchen counter receptacles
- ◆ Counter receptacles within 6' of a bar sink
- ◆ Temporary power at construction sites

GFI receptacles can detect any current not following the normal path, which happens when a person get shocked, and shut off the electricity in milliseconds.

Receptacles installed on 20A circuits may be rated at 15A or 20A. But those installed on 15A circuits can't exceed a 15A rating. If a circuit serves only a single receptacle, the receptacle must be rated at least as high as the circuit breaker.

LIGHTING

At least one wall switch-controlled light must be provided in each of the following locations:

- ◆ All habitable rooms (used for living, sleeping, eating or cooking)
- ◆ Bathrooms
- ◆ Hallways
- ◆ Stairways - Any interior stairway with 6 steps or more must have a switch at each floor level.
- ◆ Attached garages and detached garages with electric power
- ◆ Outside of exterior doors
- ◆ Attics, underfloor spaces, basements and utility rooms if used for storage or if they contain equipment requiring servicing - The switch must be located at the point of entry.

No hanging light fixtures, lighting track or ceiling fans are allowed above bathtubs. Light fixtures intended for use in wet or damp locations must be marked as approved for such locations.

Light fixtures in clothes closets must be at least 12" from a storage area, or 6" if they are recessed or fluorescent. Two storage areas are defined in clothes closets by the electrical code:

- 1) The lower storage area extends horizontally 24" from the back and sidewalls and vertically from the floor to 6' above the floor, or to the highest clothes pole, whichever is higher.
- 2) The upper storage area extends horizontally 12" from the back and sidewalls or the width of the shelf, whichever is wider, and vertically from the top of the lower storage area to the ceiling. A safe place to put a light fixture in a clothes closet is on the wall above the door. If it must be on the ceiling, keep it away from shelves and clothes poles.

SERVICES AND SUBPANELS

Every electrical panel must have a permanently clear working space in front of it at least 30" wide, 3' deep and 6 1/2' high. This space can't be used for storage. For indoor panels, the working space must be lighted.

Circuit breakers or fuses are not allowed in bathrooms or in the presence of easily ignitable materials such as in clothes closets.

The loads controlled by each circuit breaker must be identified in a legible and durable manner on the panel.

OVERHEAD SERVICE DROPS

The general rule requires overhead service drop conductors to be at least 8' above a roof. If the roof is designed for human occupancy, such as a deck above enclosed space below, the clearance must be at least 10', if the slope of the roof is 4:12 or steeper, the required clearance is reduced to 3'. This clearance may be further reduced to 18" above an overhang provided that the length of the conductors above the overhang doesn't exceed 4' measured horizontally or 6' measured along the slope of the conductor.

The conductors must be at least 12' above the ground, paving, or other surfaces accessible to vehicles. For surfaces accessible only to pedestrians, the clearance may be reduced to 10'.

Overhead service drops are installed by PG&E, but it is the property owner's responsibility to extend the service mast high enough to meet required clearances. PG&E standards call for bracing of a rigid metal conduit mast if its height above the roof exceeds 42" for 1 1/4" or 1 1/2" conduit, and 54" for 2" conduit.

DISCONNECTING MEANS

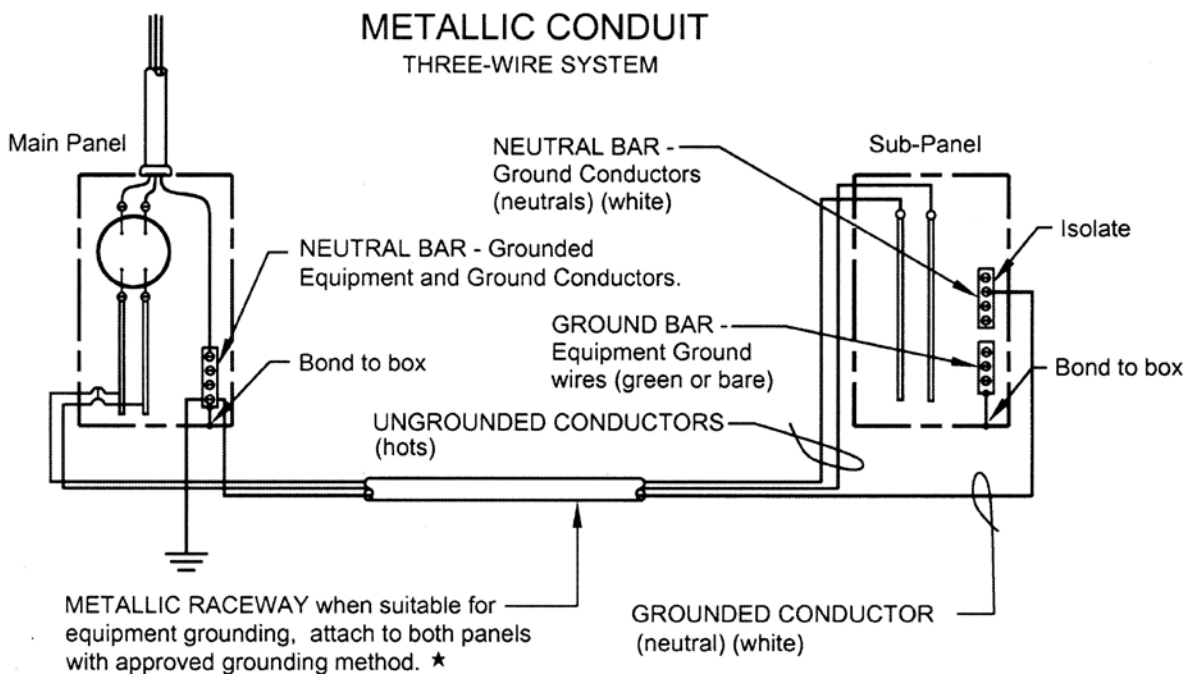
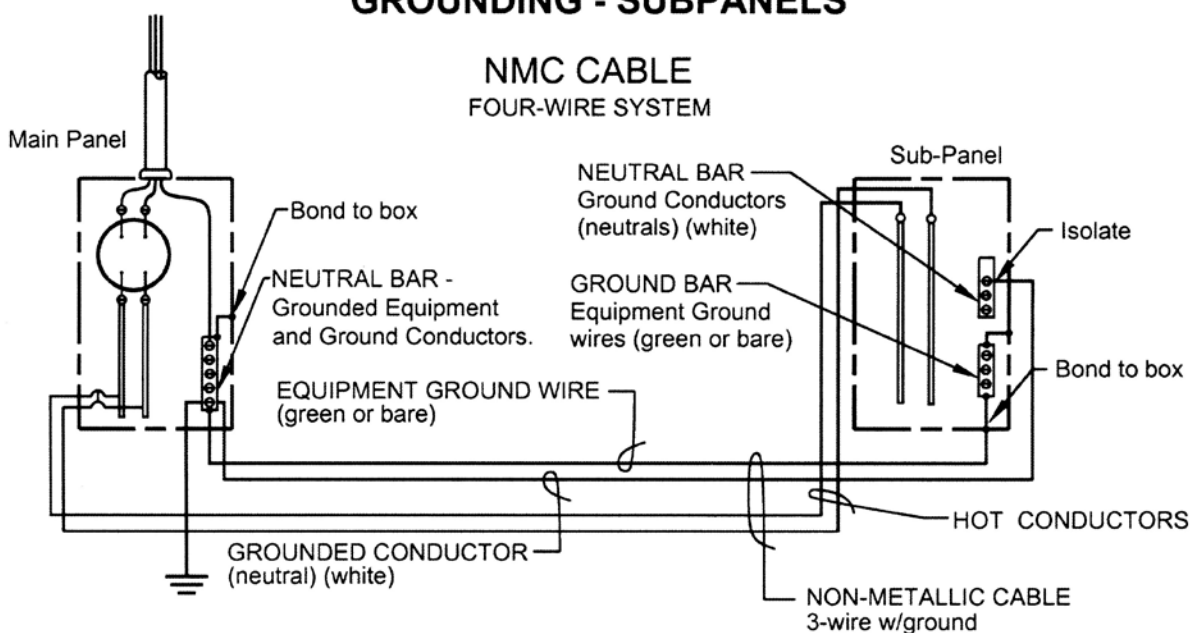
For a one family dwelling the feeder disconnecting means shall have a rating of not less than 100 amperes, 3-wire. This disconnecting means must be in or on the building served by the panel and must be readily accessible to the occupants of the building. Readily accessible means the panel cover must not be locked shut and be readily accessible to the occupants of the building.

GROUNDING ELECTRODES

Each service must be provided with a grounding electrode. Two methods are commonly used to meet this requirement. In new construction, 20' of 1/2" (#4) or larger rebar embedded in the concrete footing can be used. It must be near the bottom of the footing and be surrounded by at least 2" of concrete. It is typically bent upward to project above the top of the foundation near the service. The 20' embedded portion need not be a single bar, but splices must be tight enough to assure good electrical contact. For existing buildings, a ground rod is usually used, that must be driven at least 8' into the earth.

The wire that runs from the grounding electrode to the service is called the grounding electrode conductor. A typical 200 AMP service in a new residence requires a 4 AWG copper grounding electrode conductor. Minimum sizes for larger and smaller services can be found in table provided. The connection of this conductor to the grounding electrode must be permanently accessible. The grounding electrode conductor or the conduit in which it runs must be securely attached to the surface of the building or structure if exposed. If it runs in conduit, the ends of the conduit must be securely attached to the grounding electrode and the service enclosure. This requires a special clamping device at the grounding electrode that clamps the conductor and the conduit separately.

GROUNDING - SUBPANELS



★ (Non-Metallic Raceway, Provide 4th Wire For Equipment Grounding.)

A sub panel in a garage or other detached accessory building, which is fed by the main service at the house, must have a separate grounding electrode. If the feeder from the main service is only 3 wires (2 hots and neutral) the grounding electrode conductor at the sub panel must be bonded to the neutral. If the feeder has four wires (2 hots, neutral and ground) the grounding electrode conductor at the subpanel must be isolated from the neutral, even though they are bonded together at the main service. The reason for this is if you cut the neutral wire of an active circuit and hold one cut end in each hand, you will be electrocuted. Properly installed ground wire will protect you from being electrocuted. But when you bond the neutral and ground together, the ground wire from that point back to the beginning of the circuit shares the current carried by the neutral and can electrocute you. For that reason, the bonding together of these two wires must only occur at the origin of the ground wire.

BONDING

Metal water pipes must be bonded to ground at the main service. This is not to ground the service, which must be grounded by other means discussed above, but rather to make sure that the water pipes are grounded. If the water pipes should become energized, the current will take the path of least resistance to ground. By bonding them to a reliable ground at the service, the current will be more likely to go there instead of through a person who might touch the energized pipe. The conductor used for this purpose must be the same size as required for the grounding electrode conductor. The connection of this conductor to the pipe must be permanently accessible and located not more than 5 feet from point of entrance to the building.

Bonding is also required at the water heater. A bonding jumper wire that ties the hot, cold and gas piping systems together using the same size conductor as required for the main ground must be installed at the water heater piping.

Before PG&E will energize a new electric service, it must be inspected and approved by the Building Department.

ROUGH WIRING

GENERAL ROUGH WIRING REQUIREMENTS

Single conductors are only permitted in conduit or in a sheathed cable assembly. When run in conduit, all conductors of the same circuit, including the equipment ground, must be in the same conduit.

Holes in framing members for cables or conduit that are not at least 1 1/4" in from the edge, require a steel plate at least 1/16" thick, to protect the wiring from nails or other fasteners. Holes in steel framing members used for non-metallic sheathed cable must have bushings or grommets securely fastened in them. Cables or conduits which run parallel to framing members must be securely supported at least 1 1/4" from the face of the member or protected along their entire length by a steel plate or sleeve at least 1/16" thick.

Wires should not be bundled, since it interferes with dissipation of the heat they produce when carrying current. The codes allows bundling for no more than 24", which allows getting through choke points such as the hole(s) in the wall plates at electrical panels.

All boxes and other enclosures containing splices, connections, or ends of conductors must be permanently accessible.

GROUNDING

All noncurrent-carrying metal parts of electrical enclosures, boxes and conduits must be grounded. Sheet-metal screws shall not be used to connect grounding conductors to enclosures, connection must be made by means of a [green] grounding screw that shall be used for no other purpose, or a listed grounding device." A box cannot be grounded only by the installed receptacle, switch, light fixture, etc. Unthreaded conduit must be bonded to enclosures with bonding locknuts or bushings. Standard locknuts and bushings don't provide an adequate connection.

All grounding conductors in a box must be tied together in such a manner that the removal of the device installed in the box will not interrupt the grounding continuity. This must be completed at the rough wiring inspection, since it will be concealed at final inspection.

In addition to the grounding requirements above, an equipment grounding conductor must be attached to the device installed in a box. This conductor must also be in place at rough wiring inspection.

In previous editions of the CEC, it wasn't necessary to run a dedicated equipment grounding conductor to ranges and dryers. They could be grounded by means of the insulated neutral conductor. This is no longer the case. Both ranges and dryers must have separate equipment grounding conductor (green insulation or bare) in addition to the insulated neutral (white) and two hot conductors. This also means 4-prong receptacles are now required for these appliances.

UNDERGROUND CONDUCTORS

Only type USE conductors and type UF cable can be direct buried in the earth. All other underground conductors and cables must be in conduit. Direct-buried conductors must have at least 24" of cover on top of them. The required cover can be reduced to 18" when the conductors are in conduit approved for burial, normally rigid nonmetallic conduit. Where underground conductors emerge from the ground, they must be protected with conduit from the required underground depth to the point where they enter the building. Where direct buried conductors enter this conduit they must be protected from the edge of the conduit by a bushing or other device listed for the purpose.

TYPE NM CABLE

Type NM cable, often called “Romex”, is the most commonly used wiring method in residential construction. It should only be used in dry locations. Where subject to physical damage it must be protected. This applies to garages, unfinished basements, and other places where the framing is exposed and the wiring is installed less than 8’ above the floor. It also applies to attic wiring within 6’ of an attic access opening. The radius of the inner edge of bends must not be less than 5 times the cable diameter. When the cable is not round, the largest dimension is considered the diameter.

Type NM cable must be supported with listed staples or similar devices at least every 4 1/2 feet and within 12” of every cabinet, box or fitting which it enters. It must also be clamped with a listed device where it enters these enclosures. There is one notable exception to this last requirement: it may enter a single-gang non-metallic box without being clamped if it is secured within 8” of the box. In all cases, the cable sheathing must extend beyond the clamp or opening into the box at least 1/4”. Cables passing through holes in framing members are considered supported.

WIRING IN ELECTRICAL BOXES

Neutral conductors must be spliced together in boxes so that removal of the switch, receptacle, light fixture, etc. will not interrupt the continuity of the circuit. This is similar to the requirement for grounding conductors described above.

The ends of all conductors entering boxes must have sufficient length to project at least 6” beyond the face of the box. Without this length, the necessary splices and terminal connections can’t be made in a safe strain-free manner. The extra length is normally folded back into the box.

The CEC limits the number of conductors which can enter a box based on the interior volume of the box, the sizes of the conductors, the presence of internal cable clamps or support fittings, and the number of switches or receptacles. The actual calculations can be complex, but if you have trouble fitting everything into the box in a safe and orderly manner, the box is probably too small. Extensions are available for most electrical boxes that can solve this problem.

Unused openings in electrical enclosures must be effectively closed in a manner that provides protection similar to the wall of the enclosure. Listed plugs are available to meet this need.

Boxes installed in wood-framed walls and ceilings must be flush with the finished surface.

SWIMMING POOLS AND SPAS

OUTDOOR POOLS, INDOOR POOLS, AND OUTDOOR SPAS

A 110V receptacle must be installed no less than 6' and no more than 20' from the water's edge. Any receptacle less than 20' from the water must be protected by a GFI. No receptacles are permitted less than 6' from the water.

Lights and ceiling fans must be at least 5' horizontally from the water or 12' above it. Lights between 5' and 10' from the water must be GFI protected and securely mounted on a wall or equally rigid structure.

Switches must be at least 5' from the water unless separated from the pool or spa by a wall, fence, or similar structure.

Overhead electrical conductors must be at least 22' above the water level throughout an area extending 10' beyond the water's edge in all directions. They must also be at least 14' above all diving boards and other structures associated with the pool.

INDOOR SPAS

A 110V receptacle must be installed no less than 5' and no more than 10' from the water's edge. Any receptacle less than 10' from the water must be protected by a GFI. No receptacles are permitted less than 5' from the water.

Lights and ceiling fans must be at least 5' horizontally from the water or 7' 6" above it and GFI protected.

Switches must be at least 5' from the water.

JETTED BATHTUBS

The difference between a spa and a jetted bathtub per the CEC is that a bathtub is normally drained after each use and a spa is not.

Receptacles within 5' of jetted bathtubs must be GFI protected. This includes the receptacle serving the pump motor.

CALIFORNIA ENERGY EFFICIENCY STANDARDS

PURPOSE AND SCOPE

The purpose of the California Energy Efficiency Standards is to regulate the source energy consumption of buildings. Source energy includes all energy consumed in the production and delivery of the energy used in a building. For example, a typical method of producing electricity involves locating an underground oil field, drilling a well to access it, pumping it into shipping containers, transporting it to the generating plant, converting it to electricity, and distributing it to the end user, as well as the considerable paperwork involved throughout the entire process. Each of these processes consumes energy. The total source energy for the electricity used at the building includes the energy consumed by all of these steps in addition to the energy in the oil itself.

The underlying reason for energy efficiency being mandated by law has its roots in the oil shortages of the 1970's. Our dependence on foreign oil became a national security issue. If we used less energy, the lawmakers reasoned, we would be more independent. More recent events, deregulation, spiraling energy costs, rolling blackouts etc., have reemphasized the need for energy conservation.

MANDATORY REQUIREMENTS

All residences must meet certain mandatory energy efficiency requirements, regardless of the compliance method used. These are listed on the MF-1R form, the Mandatory Measures Checklist, which must be submitted for all new conditioned residential space.

PILOT LIGHTS

Continuously burning pilot lights are prohibited in central furnaces, cooking appliances, pool heaters and spa heaters.

JOINTS AND OPENINGS

"Joints and other openings in the building envelope pe that are potential sources of air leakage shall be caulked, gasketed, weather stripped, or otherwise sealed to limit infiltration and exfiltration."

MINIMUM INSULATION

Minimum insulation levels in frame walls are R-30 ceilings, R-13 walls, and R-19 floors. In order to show compliance for the overall building, one or more of these will most likely need to be higher, but they can never be lower in new construction, even if the calculations show that the overall building complies that way.

FIREPLACES

Masonry and factory-built solid-fuel fireplaces must have:

- ◆ Closable metal or glass doors covering the entire opening of the firebox
- ◆ A closable combustion air duct from outside the building into the firebox, at least 6 square inches in area
- ◆ a flue damper with a readily accessible control

If the fireplace is on a slab floor and not located on an exterior wall, the combustion air duct is not required.

SETBACK THERMOSTAT

Central heating and cooling systems are required to have a programmable thermostat with at least two separate periods within 24 hours.

WATER HEATER INSULATION

Water heater efficiency is rated with an energy factor (EF). Gas water heaters with an EF rating less than .58 are required to have an R-12 external insulation blanket. The EF is not always marked on the water heater, nor is it always given in the literature that comes with the heater. If this is the case, manufacturer's documentation of the EF must be requested from the supplier or manufacturer of the heater.

The first 5' of hot and cold water piping from the water heater must be insulated with R-4 pipe insulation. This insulation requirement also applies to all piping in hot water recirculating systems.

LIGHTING

All permanently installed luminaires (light fixtures) shall be high-efficacy with exceptions as listed:

Kitchens: Up to 50 percent of the total rated wattage of permanently installed luminaires in kitchens may be in fixtures that are not high-efficacy luminaires, provided that separate a switch control those fixtures.

Bathrooms, garages, laundry rooms, and utility rooms: Permanently installed luminaires that are not high-efficacy can be allowed provided an occupant sensor type switch controls them. Such motion sensors can not have a control that allows the luminaire to be turned on automatically or that has an override allowing the luminaire to be always on.

Other Interior Spaces: Permanently installed luminaires that are not high efficacy shall be allowed provided that a dimmer switch or an approved occupant sensor switch controls them. Closets less than 70 square feet can have any type of lighting.

Porches and outdoor lighting: Outdoor lighting that are not high-efficacy shall be allowed provided that they are controlled by a motion sensor. Light fixtures in or around swimming pools and water features need not be high-efficacy luminaires.

All light fixtures that are recessed into insulated ceilings must be marked "IC" for insulation contact, and shall be airtight type.

COMPLIANCE METHODS

The 2008 Energy Efficiency Standards recognize only two methods of showing residential compliance; packages (prescriptive method) and computer analysis (performance method). The hand calculated point system that was allowed in previous editions of the Standards is no longer recognized.

Both compliance methods require the submission of the CF-1R and MF-1R forms. The CF-1R, Residential Certificate of Compliance, provides a general description of the building and how it will comply with the Standards. The MF-1R, Mandatory Measures Checklist, lists all mandatory requirements and shows which ones apply to the building.

The documents submitted to show compliance become part of your approved plans. These documents show the required levels of insulation, the maximum U-value and SHGC (solar heat gain coefficient) of the windows, and minimum efficiency of the furnace, air conditioner, and water heater. In order to avoid unpleasant surprises during inspections, you should be aware of the requirements in this documentation.

PACKAGE COMPLIANCE - PRESCRIPTIVE METHOD

Package compliance is the simplest to document, but allows the least amount of choice in how the building will comply with the Standards. It consists of a list of building features that must be provided. There are actually four such lists to choose from, but the first three are special-purpose construction methods that are seldom used in our area. These lists prescribe minimum insulation levels, maximum U-value and SHGC ratings for glazing, maximum amount of glazing (based on a percentage of the floor area), thermal mass in some cases, and appliance efficiency.

The fourth list (Package D) requires the following:

- R-38 ceilings
- R-19 walls
- R-19 raised floors
- Maximum .65 glazing U-values
- Maximum glazing area of 16% of the conditioned floor area
- Maximum .40 Solar Heat Gain Coefficient for west and east-facing windows
- Minimum .78 AFUE-furnace
- Minimum 10.0 SEER air conditioning (if installed)
- A gas water heater of 50 gallons or less

Most of these requirements can be met using typical local construction methods, except for the wall insulation, which is usually R-13, and low-E (maximum .40 SHGC) windows on the east and west sides.

No documentation is normally required other than the two basic forms listed above. The CF-1R simply indicates that Package D (or A thru C) is the compliance method and lists all the relevant building features to show that all the requirements in the Package list will be met. These forms are available at the Community Development Department counter.

APPROVED COMPUTER PROGRAMS - PERFORMANCE METHOD

This compliance method allows the most flexibility in the design of the building, but is normally done by a professional energy consultant, due to the cost and complexity of the software. These programs are based on the “Standard” Package D described above, but other than meeting the mandatory minimums, unlimited trade-offs can occur. For example, if you wish to have more than the prescribed amount of window area, you can make it up by using better-than-required U-values, a more efficient furnace, etc. The software calculates all these trade-offs and determines whether or not your design will be as efficient as Package D. In most cases, the program prints all of the required forms.

ADDITIONS AND ALTERATIONS

ADDITIONS

An addition is an increase in both floor area and volume of conditioned space.

Prescriptive compliance for additions is generally the same as for new buildings. Each requirement listed for the selected package must be met. However, the following modifications of Package D are permitted for additions of less than 1000 square feet:

- ◆ Additions of less than 100 square feet require minimum insulation of R-30 ceiling, R-13 walls, and R-19 wood floors. Windows must be no more than .67 U-value with no SHGC requirement and must not exceed 50 square feet of area. Heating and cooling appliances need only meet mandatory requirements and water heating need not be considered.
- ◆ Additions of less than 500 square feet may have R-13 wall insulation. Windows must be no more than .67 U-value and their area is limited to 16% of the floor area plus any glazing removed to allow for the construction of the addition. Water heating need not be considered.
- ◆ Additions of 500 to 999 square feet may have R-13 wall insulation and the window area is limited to 16% of the floor area plus any glazing removed to allow for the construction of the addition.

Performance compliance for additions is shown with an approved computer program. There are three ways to show compliance for additions using the performance analysis method. The first and most common is to analyze the addition alone in the same way a new building would be done. If the addition doesn't comply that way, the existing-plus-addition method can be used. This method credits improvements in the existing building toward the addition. It will always help the calculations somewhat due to the elimination of a portion of the existing exterior wall where the addition attaches to the existing building. This makes the existing portion of the building more energy-efficient. If improvements such as window replacements are being done in the existing building, it will help the calculations quite a bit. The third and least used method is the whole building method, which would only be useful if the existing building is very energy efficient and the addition is not. In this method, the existing and new portions of the building are considered together as if it were an entirely new building.

ALTERATIONS

An alteration is a change in the building that is not an addition. The construction of a loft in a room with a high ceiling would be an increase in floor area but not in volume, so it would be an alteration. If a ceiling is raised, it increases the volume but not the floor area, so that would also be an alteration. Like new buildings and additions, alterations can be shown to comply with either a prescriptive or performance analysis method.

Prescriptive compliance for alterations requires all of the following:

- ◆ All applicable mandatory requirements must be met
- ◆ Newly installed and relocated windows must be maximum .67 U-value
- ◆ Gas appliances can't be replaced with electric ones

Performance compliance for alterations can be shown with an approved computer program. It would be used where the prescriptive requirements are not acceptable. Unlike new buildings and additions, alterations don't have a newly conditioned square footage. But the programs still ask for such a figure. The code says this figure should be "The permitted space alone, which shall be a minimum of the square footage of the room in which the alteration is made." In other words, it should be the area involved in the work, with a minimum of one room. There is also an existing-plus-alteration method, similar to the existing-plus-addition method, where improvements made to other portions of the building can be credited to the alteration.